Exhibit 11

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

SECURITIES AND EXCHANGE COMMISSION,

Plaintiff,

v.

RIPPLE LABS INC., BRADLEY GARLINGHOUSE, and CHRISTIAN A. LARSEN,

Defendants.

20-cv-10832 (AT)

EXPERT REPORT OF PETER ADRIAENS

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I. Introduction

A. Relevant Expertise in Blockchain Technology and Entrepreneurship in Digital Industries

1. I, Peter Adriaens, am a Professor of Engineering, Finance and Entrepreneurship at The University of Michigan (1992-current). I hold appointments in Civil and Environmental Engineering at the Ross School of Business and the School of Environment and Sustainability. I am a member of the American Academy of Environmental Engineering, and a member of the National Academy of Engineering in Belgium. I have held distinguished professorships in Entrepreneurship and Finance at Sichuan University (China; 2006-2016), and a Finnish Distinguished Professorship at the Research Institute of the Finnish Economy (Helsinki; 2013-2016).

2. I am an engineer and scientist by training with an undergraduate (1984) and master's (1986) degree from the University of Gent, Belgium, a doctorate (1989) from the University of California, Riverside, and postdoctoral training (1992) at Stanford University. I have devoted a substantial portion of my career – both in and outside the classroom – to two fields: blockchain technology and entrepreneurship in digital industries.

3. Since 2006, I have worked in the area of finance and entrepreneurship as a faculty member at the Ross School of Business through the Zell-Lurie Institute for Entrepreneurial Studies. As one of the leading Professors of Entrepreneurship at the University of Michigan, I developed and have taught courses on Entrepreneurial Business Fundamentals, CleanTech Entrepreneurship, and Business Model Design for business (MBA) and engineering domain expert students. Over 1,200 students have participated in my entrepreneurship courses. Course work covers entrepreneurial strategy, marketing, financing and valuation of startups, and business model design. Students are expected to engage with a wide range of startups, including

in digital finance. I have developed and have taught courses on Engineering Economics and Finance, Infrastructure Project Finance, Environmental Finance, and Blockchain Finance.

4. Since 2015, my expertise has focused on financial technology ("fintech") applications, financial modeling, and blockchain tokenization of infrastructure assets. My research and teaching focus on digital business and finance models for infrastructure, blockchain applications for "smart cities" infrastructure, and artificial intelligence/machine learning models for pricing of sustainability premiums in the fixed income (corporate and municipal bonds) and equities markets. This work is done in collaboration with – and sponsorship from – financial, corporate, and high-tech startup clients seeking to differentiate in the digitization of real assets and application of cryptocurrencies for infrastructure financing.

5. Since 2016, I have directed the Center for Smart Infrastructure Finance[1] and associated namesake Master of Engineering program[2] at the University of Michigan. The Center focuses on efficient (data-driven) financing mechanisms for public and private infrastructure systems such as water, energy, waste, transportation, and mobility. This includes blockchain tokenization models and other digital asset monetization structures. The Center is a cofounder of the University of Michigan FinTech Collaboratory, along with the FinTech Initiative[3] in the University of Michigan Ross School of Business and the Center on Finance, Law & Policy[4] in the University of Michigan Ford School for Public Policy.

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[1] *Center for Smart Infrastructure Finance*, University of Michigan, https://www.difin.io.

[2] *Smart Infrastructure Finance MEng*, University of Michigan, https://masters.engin.umich.edu/degree/smart-infrastructure-finance-meng/.

[3] *Michigan Ross FinTech Initiative*, University of Michigan, https://michiganross.umich.edu/faculty-research/institutes-centers-initiatives/fintech-initiative.

[4] *Center on Finance, Law & Policy*, University of Michigan, https://fordschool.umich.edu/research-center/center-finance-law-policy.

6. I also supervise a research group at the University of Michigan, funded by research grants from government agencies and corporate contracts. The team consists (time variable) of around 6 undergraduate and 10 graduate (Master's and PhD-level) students, as well as a postdoctoral researcher, who work on a wide range of fintech projects. The group's work is not narrowly limited to blockchain and cryptocurrency research, but includes the broader application of digital models in finance. Examples include infrastructure asset tokenization, a blockchain application for digital delivery of construction projects, and blockchain platforms for integration of financial and impact (environmental, social, and governance) for resilient infrastructure. This work has been presented at academic risk management meetings (e.g. International Risk Management in Banking and Finance), Asian Development Bank/European Investment Bank (ADB/EIB) conferences on blockchain financing of infrastructure assets in emerging and developing countries, and National Science Foundation-funded conferences for mathematical societies. In addition, I serve on the editorial review board of the Journal of Blockchain Research, a leading, if fairly new, peer-reviewed journal in this area.

7. I also serve as a faculty mentor to Blockchain@Michigan,[5] a student group engaged in peer-to-peer training modules for smart contract coding and decentralized application (dapp) development with a wide range of industry partners. These industry partners include public corporations, financial institutions, and technology companies.

8. Setting aside my teaching and research, I also have substantial practical experience from which I derive expertise in blockchain technology and entrepreneurship. During the past 15 years, I was an advisory board member of the Wolverine Venture Fund[6] and the Lurie

[5] *Blockchain at Michigan*, https://www.michiganblockchain.org.

[6] *Wolverine Venture Fund*, University of Michigan, http://zli.umich.edu/wolverine-venture-fund.

Commercialization Fund, focused on investments in technology companies, including increasingly digital innovations and cryptoassets. As an advisor to the funds, my role was to identify early-stage companies for potential (seed or A round) investment, work with the analyst teams on due diligence analysis to assess the company's attractiveness for equity investment, and participate in the ultimate recommendations for financing.

9. From 2013-2016, I worked as Director on the financial research program at the Research Institute of the Finnish Economy. I focused on economic transitioning under climate risk constraints, and oversaw a team of 15 experts in finance, digital assets, and business models. A substantial fraction of this work emphasized algorithmic financial decision-making in startups and lending to corporations, culminating in a book I co-authored with a colleague at the Institute on "Financial Technology for Industrial Renewal."[7] The research program focused on the development of a new type of multi-asset investment model structure to enable systemic economic development. The investment models were piloted in the energy, transportation mobility, and green chemistry industry sectors. Multi-asset means that the model sought to blend investments in thematic publicly traded indexes, equity investment funds, and business loan portfolios. The decision tool to select companies for investment – and to assess which type of investment was most appropriate – was a digital, rules-based algorithm, rendering this an attractive value proposition for a blockchain application. At the time of the program, blockchain and cryptocurrencies were still incipient, but the premise of an open ledger was considered and discussed among the team's partners.

10. I serve and have served on several advisory boards for companies and organizations that are focused on advancing the blockchain and cryptocurrency industry, and new applications with

[7] *Financial Technology for Industrial Renewal*, ETLA, https://www.etla.fi/en/publications/financial-technology-for-industrial-renewal/.

societal and financial value. These include, for example, Detroit FinTech Bay (DFB), a for-profit startup incubator with emphasis on attracting leading technology companies in the payments and enterprise software space, in partnership with commercial banks seeking fintech solutions. I am engaged as a partner and advisory board member with Blockchain Triangle, a fintech platform and issuer of digital assets that focuses on the integration of environmental, social, and governance (ESG) criteria in financial investments using blockchain tokens.[8]

11. I also am cofounder of and investor in two startups. The first is Corymbus Asset Management, which was financed through client contracts (as opposed to venture capital or other forms of equity financing). The second is Equarius Risk Analytics (ERA)[9], which is currently in the seed/A round-financing stages. ERA is a fintech firm focused on using mathematical algorithms that price the impact of water risk (water availability, droughts, floods) in share price volatility and investment returns. These insights are then used to build indexes that can be licensed to investment managers. Recently, the company has focused on tracking financially-material water risk across corporate facility portfolios for Nikkei 225 and S&P 500 companies. The distributed allocation risk from a single listed corporation to its portfolio of facilities and operations renders this an attractive application for blockchain technology, which allows for tracking financial and water risk metrics across a network of facilities (nodes) in a wide range of geographies.

B. Relationship to Ripple Through UBRI

12. Ripple Labs Inc. ("Ripple") funds what is known as the University Blockchain Research Initiative ("UBRI"). UBRI brings together dozens of global universities in the U.S., Europe, and

[8] *Blockchain Triangle*, http://www.bctriangle.com. The company is a registered member of the Bermuda Business Development Agency under its new Digital Asset Business regulatory regime. *See Digital Assets Supervision and Regulation in Bermuda*, Bermuda Monetary Authority, https://www.bma.bm/digital-assets-supervision-regulation.

[9] *Equarius Risk Analytics*, https://www.equariusrisk.com.

Asia to "support and accelerate academic research, technical development and innovation in blockchain, cryptocurrency and digital payments."[10] While the FinTech Collaboratory (an initiative across three schools, as mentioned in ¶ 5) is funded in part by a gift from UBRI, the Center for Smart Infrastructure Finance I direct (mentioned in ¶ 5, and a member of the Collaboratory) has multiple other sources of funding, including from Nuveen, Blockchain Triangle, and Ford, as well as gifts from other alumni in the financial services industry. This gift arrangement came about through Asheesh Birla, then Ripple's Head of Product and now the General Manager of RippleNet. Mr. Birla is a University of Michigan alumnus and was until the first half 2018 our Ripple lead contact for UBRI; he reached out to inquire about the University of Michigan's strengths in blockchain and interest to join UBRI. His inquiry brought the University of Michigan Engineering, Business, and Policy Schools together under the current UBRI gift program. I have not had contact with Mr. Birla since the University joined UBRI, because (as I explain below) his role as Manager of University Partnerships at Ripple was taken over by Lauren Weymouth, who became Director of University Partnerships in August 2018. As part of UBRI, the University of Michigan maintains a validator node on the XRP Ledger (which I describe in greater detail below), but the University of Michigan has not actively participated in voting on the XRP Ledger because of University policies governing services under corporate gift agreements.

13. The original gift agreement with the University of Michigan was $1 million and was executed in December 2018 for a period of 2 years, with a possibility of extension and refunding. That original gift was paid out in two installments (half in 2019, half in 2020). The funds were allocated between the Center for Infrastructure Finance in the College of Engineering, the Center

[10] *University Blockchain Research Initiative*, Ripple, https://ubri.ripple.com/.

on Finance Law and Policy in the Ford School for Public Policy, and the FinTech Initiative at the Ross School of Business. In April 2021, the gift was extended for another two years with funding of $250,000 per year, again split between the three schools mentioned in the original gift agreement.

14. As an UBRI member, I engage with faculty colleagues and students in research and community outreach projects, as well as in teaching and mentoring, and participate in the annual UBRI conference which brings together all of the global universities that have received funding under this partnership program. I attended the first UBRI conference gathering at the University of California, Berkeley in 2019, which provided further insights in the diversity of underlying technologies behind the XRP Ledger, its commercial uses and business models, challenges with product deployment, and development of business cases. The conference is structured such that it facilitates discussions of research and teaching activities with colleagues worldwide on topics such as security, decentralized finance ("DeFi"), "blockchain for good," and blockchain policy. The second conference was held virtually in 2020.

15. There is no commercial or contractual pay-for-service relationship between myself or the University of Michigan on the one hand and Ripple or UBRI on the other. Pursuant to University of Michigan gift and donations policies,[11] the UBRI gift serves to advance research and teaching objectives of the recipient University of Michigan schools without interference or undue influence; it does not have specific expectations or deliverables from University of Michigan (or other university) recipients of these gifts or the faculty members associated with UBRI initiatives. My communications with Ripple since December 2018 regarding UBRI have been limited to Ms. Weymouth, Director of University Partnerships at Ripple (manager of the

[11] University of Michigan, *Standard Practice Guide Policies: Gift Acceptance*, https://spg.umich.edu/policy/602.02.

UBRI network). These interactions pertain to the use of the gift funds at the University of Michigan, and our participation in the annual UBRI conference. While the Defendants speak at the conference, the conversations between them and the participants are limited to research needs and opportunities.

16. Aside from my work in this matter and what I have described here, I have no relationship with Ripple. I have no relationship with Chris Larsen or Brad Garlinghouse and have never met or spoken with either of them. Further, I own no XRP and am not a shareholder in Ripple.

17. The opinions and views presented in this work are independent and entirely based on my business and digital innovation expertise.

C. Summary of Opinions

18. My assignment in this case is to offer testimony concerning certain topics that draw on my expertise in blockchain technology and entrepreneurship regarding Ripple, the XRP Ledger and XRP. In particular, my opinions are as follows:

19. **Opinion 1. The XRP Ledger and its native currency, XRP, represented an important innovation in blockchain technology.** Blockchain technology has the potential to transform many sectors of the economy, and has already begun to do so. The XRP Ledger, and consequently XRP, represent an important innovation in the application of blockchain technology to payment systems. In particular, when the XRP Ledger was launched, blockchain ledgers required mining to close and validate transactions involving cryptocurrencies such as Bitcoin and Litecoin – a process that takes at least 10 minutes to confirm a transaction and entails detrimental environmental effects. The XRP Ledger was only the second ledger (after bitcoin), and was the first ledger on which transactions were to be validated using a consensus mechanism that did not rely on mining. As a result, the XRP Ledger offered one of the fastest and cheapest blockchain technologies with negligible energy consumption, and therefore

introduced and continues to have a value proposition that addresses some of the inefficiencies and externalities of prior proof of work validation mechanisms.

20. **Opinion 2. Ripple's iterative development of its business model and products is consistent with start-up practice in high-technology industries.** It is typical for a technology startup to pivot multiple times on product and business models as it encounters technical challenges, receives market feedback from partners for target applications, responds to regulatory changes, or adjusts value propositions in reaction to societal forces. Issues of security, confidentiality, trust, and reactions from incumbents or market makers result in a new articulation of the value proposition and scalable commercial product with broad adoption potential. The development of applications leveraging blockchain technologies in general, and Ripple's business model in particular, required a similar iterative process of developing applications leveraging the open-source XRP Ledger that would satisfy market demand (here, for blockchain-based global settlements).

21. **Opinion 3. The XRP Ledger and its native currency, XRP, have commercial utility that third parties have leveraged in the creation or advancement of their business models, demonstrating the decentralized nature of the XRP Ledger.** Ripple's vision was to allow money to move as easily as information by creating a global blockchain-based payments system that could compete with Society for Worldwide Financial Telecommunications ("SWIFT") messaging and intermediary bank transfer fees, by using the native currency of the XRP Ledger, XRP, as a bridge currency. As is typical for startup companies that articulate a bold vision, the path to that market has required Ripple to demonstrate that value proposition using targeted use cases and products with specific partners. Ripple did precisely that, as illustrated by its own product-portfolio buildout. As a platform-software services company, Ripple has aspired to

develop its own proprietary software products that utilize the XRP Ledger while also engaging an ecosystem of developers for new business applications through Xpring and RippleX, as discussed further below.

22. Moreover, as an open-source blockchain, the XRP Ledger is an innovative technology that other developers can and do use to build novel applications, which may or may not use the native currency XRP. Setting aside Ripple's vision to encourage adoption of its software products, others – various payment processors, micropayment platforms, non-profits, and other companies – have built application use cases leveraging the XRP Ledger or supporting XRP, which demonstrate these innovative uses and commercial value of these technologies.

23. I explain these opinions as follows. As background, I first address the nature of blockchain technology (in Part II) and of the cryptocurrency industry (in Part III). I then explain the evolution of Ripple's business model and the utility of the XRP Ledger and XRP in light of that background (in Parts IV and V, respectively).

24. My curriculum vitae, which includes a list of my publications and all other cases in which, during the past four years, I testified as an expert at trial or by deposition, is attached as Appendix A. The facts and data I have relied on and considered in forming my opinions are disclosed in the report or in Appendix B. In preparing this report, I have been compensated at a rate of $750 per hour for all services except for testimony during a deposition, at trial, or at any hearings, for which I will be compensated at a rate of $950 per hour. No part of my compensation is contingent on the substance of my opinions or on the outcome of this case. 25. My opinions are based on the information available to me as of the date of this report. Should additional relevant documents or information be made available to me, I may adjust or supplement my opinions as appropriate.

II. Blockchain Innovations Have Revolutionized Numerous Fields

A. Blockchain Technology is an Innovative Way To Regulate and Maintain Administrative Control Over Contracts, Transactions, and Their Records

26. Blockchain technology addresses inefficiencies in historical methods for administering contracts, transactions, and their records. Contracts are (of course) among the defining structures in our economic, legal, and political systems. They protect assets and set organizational boundaries and responsibilities; they establish and verify identities and chronicle events; they govern interactions among nations, organizations, communities, and individuals; and they guide managerial and social action. But in certain respects, contracts and the bureaucracies formed to manage them have not kept up with the economy's digital transformation. In particular, parties looking to complete a transaction and verify that that transaction was completed traditionally had to enlist the services of central validating and verifying authorities, such as banks for financial transactions, to serve as intermediaries.

27. Blockchain technology provides an innovative way to regulate and maintain administrative control over contracts, transactions, and their records. A blockchain is an open, distributed ledger that can record transactions between two parties efficiently, and in a verifiable and permanent manner that does not require the presence of intermediaries and central validating and verifying authorities. In particular, contracts are embedded in digital code and stored in transparent, shared databases, where they are cryptographically protected from deletion, tampering, and revision. Every agreement, every process, every task, and every payment has a digital record and signature (identification or ID) that can be identified, validated, stored, and shared. Ideally, blockchains enable individuals, organizations, machines, and algorithms to freely transact and interact with one another with limited friction. Five principles generally govern how the blockchain technology innovation works:

(1) Distributed (Decentralized) Database. This means that each party on a blockchain has access to the entire database and its complete history. No single party controls the data or the information. Every party can verify the records of its transaction partners directly, without an intermediary.

(2) Peer-to-Peer. Communication occurs directly between peers who plan to engage in a transaction, instead of through a central node. Each node stores and forwards information to all other nodes.

(3) Transparency and Anonymity. Every transaction and its associated quantity of cryptocurrency are visible to anyone with access to the system. Each node, or user, on a blockchain has a unique alphanumeric address that identifies it. This unique address key is pseudonymous. Users can choose to remain anonymous or provide proof of their identity to others. Transactions occur between blockchain addresses. Blockchains can be permissionless (open) or permissioned (closed to anyone not invited to have access), and multiple variations thereof, depending on the contractual problem being solved.

(4) Irreversibility of Records. Once a transaction is entered in the database and the accounts are updated, the records cannot be altered, because they are linked to every transaction record that came before them (hence the term "chain"). Various computational algorithms and approaches are deployed to ensure that the recording on the database is permanent, chronologically ordered, and available to all others with access to the ledger.

(5) Computational Logic. The digital nature of the ledgers means that blockchain transactions can be tied to computational logic and therefore can be programmed. This allows for businesses and other organizations to set up algorithms and rules that automatically trigger transactions between nodes (users of the blockchain).

28. Since blockchain transactions require unique encrypted keys or access codes, this information needs to be securely stored. This is typically done via digital wallets (or "e-wallets"). A digital wallet is a software-based system that stores users' payment information and passwords for numerous payment methods and websites. By using a digital wallet, users can complete purchases easily and quickly, and keep track of their blockchain-based transactions.

Though there are plenty of wallet programs and hardware to choose from, they generally fall under two main types: hot and cold wallets. They vary in levels of security, accessibility, and other features. A hot wallet can also be called a software wallet because it is connected to a web server, and it initiates cryptocurrency transactions via browser-based webpages.[12] Its key role is to sign and authorize financial transactions digitally between the owner and end-users. A collection of private keys stored on a program connected to the internet is used to store and send different currencies. A cold wallet, on the other hand, is a hardware wallet or cold storage, a physical device that keeps the generation and storage of cryptocurrency completely offline.[13] Many look like USB drives. Most exchanges and brokers will have a large part of their cryptocurrency in cold wallets. This makes it impossible for hackers to steal the cryptocurrency from the wallets, because of the need to be physically at this location. To start transactions, cold wallets will have to be turned on and connected to the internet.[14] Given the security trade-offs when using either type of crypto wallet, a combination of cold and hot wallets is usually ideal.

29. Digital wallets can be used in conjunction with mobile payment systems, which allow customers to pay for purchases with their smartphones. Digital interactions are executed using near-field communication technology, a set of communication protocols between two electronic devices over less than two inches in distance.

[12] *What is a Hot Wallet?* Corporate Finance Institute, https://corporatefinanceinstitute.com/resources/knowledge/trading-investing/hot-wallet/.

[13] Luke Conway, *What are the Safest Ways to Store Bitcoin?* (Feb. 28, 2021), Investopedia, https://www.investopedia.com/news/bitcoin-safe-storage-cold-wallet/.

[14] Cryptomedia Staff, *Hot Wallets vs. Cold Wallets* (July 4, 2021), Cryptomedia, https://www.gemini.com/cryptopedia/crypto-wallets-hot-cold#section-hot-wallets-pros-and-cons.

30. Chart 1 explains how a typical transaction on the blockchain works:

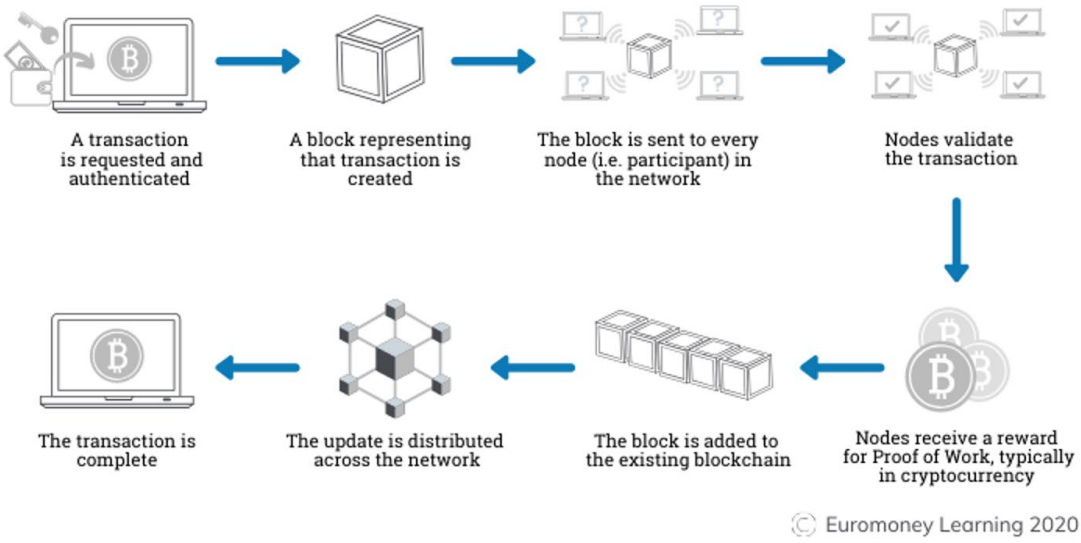

Chart 1. Typical Cryptocurrency Transaction through Digital Wallets (Source: Euromoney Learning 2020.[15])

31. Blockchain-ledger software can be designed to address many different challenges and use cases. Typically, these designs result from code modifications in the blockchain's open-source software source code, including in how transactions are validated.[16] In the latter case, this change results in what is known as a "fork" in the blockchain. That fork becomes independent of the original blockchain, and it can result in a software upgrade or even a new currency.[17] Forks

[15] *How does a transaction get into the blockchain*, Euromoney, https://www.euromoney.com/learning/blockchain-explained/how-transactions-get-into-the-blockchain. This chart illustrates a typical transaction for a ledger that uses a proof-of-work ("PoW") consensus mechanism, like bitcoin or ether. As described below, the XRP Ledger uses a different consensus mechanism (not proof of work reward system), but the sequence illustrated here of how transactions occur over the XRP Ledger blockchain is otherwise the same.

[16] *What is "Open Source" and Why Is It Important?*, Coin center, https://www.coincenter.org/education/advanced-topics/open-source/.

[17] Nate Maddrey, *Blockchain Forks Explained*, https://medium.com/digitalassetresearch/blockchain-forks-explained-8ccf304b97c8.

that are incompatible with older versions of the blockchain software are called "hard forks"; they typically result from changes in consensus rules (a concept on which I elaborate in Part II.B.2) that make previous versions of the software incompatible. A hard fork can be effectuated either by the original developer of the blockchain software or a third party. Chart 2 illustrates how a fork occurs:

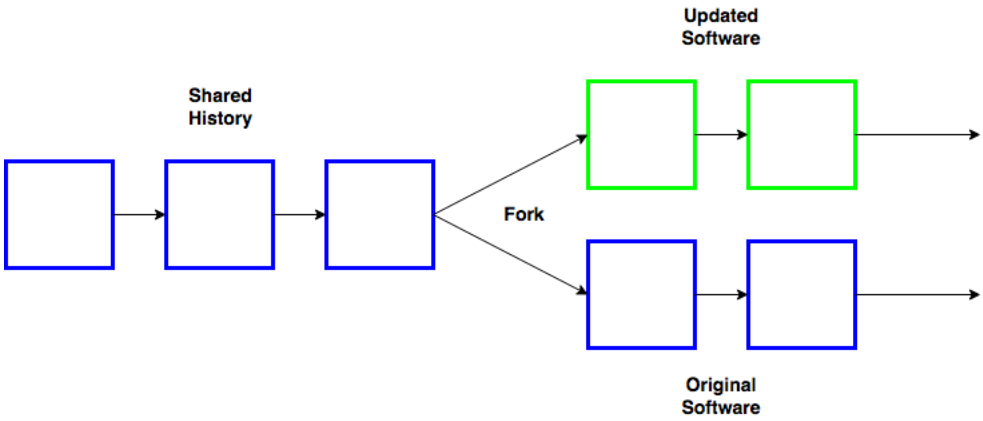

Chart 2. Hard fork on a blockchain (Source: Digital Asset Research[18])

B. Cryptocurrency Represents a Particularly Successful Application of Blockchain Technology

1. Bitcoin Was the First Successful Cryptocurrency

32. Blockchain technology enables (among other things) a novel medium of exchange known as cryptocurrency.[19] The concept of a cryptocurrency was first introduced in 2008 via a white paper published under the pseudonym Satoshi Nakamoto.[20] The document proposed an electronic payments network that does not require the trust of a third-party financial institution. The following year, Nakamoto launched the open-source Bitcoin network ("Bitcoin") in collaboration with a group of online cryptography developers.[21]

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[18] *Id.*

[19] I use the term "cryptocurrency" interchangeably with the term "virtual currency."

[20] *Bitcoin: A Peer-to-Peer Electronic Cash System*, bitcoin, https://bitcoin.org/bitcoin.pdf.

[21] "Bitcoin" (with a capital "B") refers to the blockchain; "bitcoin" (with a lower-case "b") refers to the cryptocurrency used by that blockchain; "BTC," pronounced "bitcoins," likewise refers to the cryptocurrency.

33. The primary purpose of Bitcoin was to securely store value in a public, decentralized, and self-sustained system. It achieved this using a blockchain that served as a series of records cryptographically chained together and maintained by a network of distributed computers. Each user had one or more 34-character public keys that served as a unique Bitcoin address, as well as a 64-character private key that functioned as a password. These keys were encrypted, backed up, and stored offline to prevent hackers from sending or withdrawing unauthorized funds. When a user sends bitcoin, the transaction is bundled in a block with 1,000 to 2,500 other transactions and published to the network. Transaction data include the bitcoin amount, sender and recipient public keys, transaction fee, and time stamps, as well as a unique identifier called a hash. Once a block is confirmed by the network, it is added to the Bitcoin blockchain.

34. To join the Bitcoin network, users needed to install the Bitcoin open-source software on a computer. Once installed, the computer then connects to the rest of the nodes on the network and downloads the latest Bitcoin blockchain. The computer then serves as a node on the network and allows users to send and receive digital coins called BTC ("bitcoins").

35. The Bitcoin blockchain therefore enabled the ongoing maintenance of a public ledger with irreversible records that could not be taken down or changed by a central governing body. The Bitcoin blockchain was and remains highly successful: Current estimates suggest there are over 700,000 blocks on the Bitcoin blockchain.

2. Alternative Cryptocurrencies – Many Built Atop Alternative Means of Validating Transactions – Have Since Emerged To Rival Bitcoin

36. As Bitcoin increased in popularity and the idea of decentralized and encrypted currencies caught on, the first alternative cryptocurrencies appeared. Sometimes known as "altcoins," these cryptocurrencies generally tried to improve on the original Bitcoin design by offering greater speed, anonymity, or other advantages (such as energy requirements for validation). According

to crypto market capitalization aggregators, as of May 2021, there were 10,115 different cryptocurrencies listed, with that number rising daily, across over 20,000 different types of markets.[22] Among the earliest cryptocurrencies were Namecoin (launched in 2011), XRP (launched in 2012), and ether (launched in 2015). (The latter is now the second-largest cryptocurrency in market capitalization after bitcoin.)

37. One factor that differentiates some blockchain ledgers from others is how they validate transactions. There are thousands of digital currencies (including, for example, Einsteinium, Litecoin, Dash, Zcash, and Novacoin) that use the Bitcoin blockchain codebase, with developers changing a few minor details. But some other ledgers, (including, as I will explain, the XRP Ledger) began to introduce new standards and methods for validating transactions.

38. Bitcoin and Ethereum (the blockchain for which ether is the native currency) use the **proof-of-work** (PoW) method to incentivize nodes on the network to validate transactions and to enter new BTC or ether in circulation. This means that nodes on the network, also referred to as "miners," validate a transaction by referencing the historical records on the blockchain to assure the sender has sufficient funds. Validated transactions are bundled into a block and added to a public record: the blockchain. Nodes then maintain records of those blocks so that they can be verified into the future. In blockchains that use PoW, to then determine which miner published the latest block, the nodes (I will use Bitcoin nodes here for illustrative purposes, though the same process is used for Ethereum) utilize computer processing power to solve a complex numerical problem. By solving computational math problems, Bitcoin miners make the bitcoin payment network more trustworthy and secure by verifying its transaction information. The first node to complete the problem publishes the next block to the blockchain and is rewarded new

[22] *What Are Altcoins and Why Are There Over 5,000 of Them?*, Bitcoin.com, https://news.bitcoin.com/altcoins-why-over-5000/.

BTC as well as any associated transaction fees. This creates a competition for processing power. On average, it takes the fastest miners 10 minutes to solve the problem, resulting in an approximately 10-minute confirmation time. A Bitcoin transaction is considered finalized after six confirmations, hence a 60-minute transaction time. A limitation of the Bitcoin blockchain is its throughput of seven transactions per second. At the beginning, miners received an award of 50 BTC per block. By design, the reward halves after 210,000 new blocks, or about every four years, until reaching the maximum supply of 21 million coins. In May 2020, the block reward was halved for a third time to 6.25 BTC. Unlike Bitcoin, which is designed with a maximum cap, Ethereum has no limit on the total number of ether coins that can be minted. Ether follows the same principles as bitcoin in that its rewards and distribution are regulated on a yearly basis.

39. Because new BTC are created through a computationally intensive process, the Bitcoin network – from its inception until now – is a massive draw on the world's energy resources. Until May 2021, half of all BTC were mined in China, accounting for 140 terawatts of energy. Following China's decision to expel miners, the U.S. has become the new haven for bitcoin mining, with miners seeking to draw on stranded renewable resources.[23] Still, PoW validations draw the equivalent of 70 terawatt hours of energy per year, or 0.33% of the world's total electricity production. This is roughly equivalent to the annual energy draw of countries like Bangladesh and Chile. In other words, the production of just one bitcoin consumes as much energy as 18 American or more than 1,500 Nigerian citizens per year. Currently, a single Ethereum transaction consumes as much electricity as an average U.S. household uses in a workweek, and has a carbon footprint equivalent to 140,893 Visa credit card transactions or

[23] MacKenzie Sigalos, *How the U.S. Became the World's New Bitcoin Mining Hub*, CNBC (July 17, 2021), https://www.cnbc.com/2021/07/17/bitcoin-miners-moving-to-us-carbon-footprint.html.

10,595 hours of watching YouTube.[24] Because of PoW dependence on energy generation, alternative methods of transaction validation have been developed.

40. Over the years, many alternatives to PoW have emerged.[25] Despite having similar goals, these validation mechanisms ensure consensus with different approaches that have evolved to meet emerging needs. No dominant validation mechanism yet exists, and it is difficult to predict which validation mechanisms will become the standard with broad adoption because blockchain technology itself remains fairly new.

3. The XRP Ledger Represented a Substantial Innovation in Blockchain Technology (a "better bitcoin")

41. For present purposes, I focus on the innovations underlying the second ledger to be created: the XRP Ledger.[26] The XRP Ledger was designed to improve on the promise of the Bitcoin ledger while simultaneously addressing certain of its inherent problems, including its energy consumption. Three improvements are particularly relevant: Speed of transactions, security, and environmental impact. These were enabled by features such as a decentralized

[24] Adam Bluestein, Ethereum risks it all on going green (July 29, 2021), Fortune Magazine, https://fortune.com/2021/07/29/ethereum-going-green-ether-crypto-carbon-footprint/#:~:text=Currently%2C%20a%20single%20Ethereum%20transaction,10%2C595%20hours%20of%20watching%20YouTube.

[25] These include (among others) proof of stake, *see* Emanuel Coen, *Everything You Need to Know About Ethereum 2.0 and Proof-of-Stake*, Cryptotesters, https://cryptotesters.com/blog/ethereum-staking-explained; proof of capacity, *see Proof of capacity (PoC)*, Consensus, https://tokens-economy.gitbook.io/consensus/chain-based-proof-of-capacity-space/proof-of-capacity-poc; and proof of activity, *see* Steve Walters, *Proof of Activity Explained: A Hybrid Consensus Algorithm*, CoinBureau, https://www.coinbureau.com/blockchain/proof-of-activity-explained-hybrid-consensus-algorithm/.

[26] In describing the XRP Ledger, XRP, and Ripple throughout this report, in addition to the cited sources, I am relying on my personal dealings with Ripple in connection with UBRI and developing the gift to the University of Michigan; my experience as an expert in blockchain technology; a business case I teach in my entrepreneurship courses on *"Ripple: The Business of Crypto*," authored by David B. Yoffie and George Gonzalez from the Harvard Business School (Feb. 18, 2020); Ripple's Wells Submission; and public sources including (i) Ripple, *Our Story*, https://ripple.com/company, (ii) Ripple, *XRP, Digital Asset for Real-Time Global Payments*, https://ripple.com/xrp/, (iii) XRPL.org, *XRPL Overview*, https://xrpl.org/xrp-ledger-overview.html, (iv) XRPL.org, *History*, https://xrpl.org/history.html, and (v) XRPL.org, *Decentralized Exchange*, https://xrpl.org/decentralized-exchange.html.

exchange, decentralized validation, and a unique consensus network protocol, as will be discussed hereafter.

42. Decentralized exchange. A notable feature of the XRP Ledger – which represented a significant innovation over Bitcoin, the only other ledger in existence at the time of its creation – is that the XRP Ledger contains a fully-functional decentralized exchange, called the "Dex." The Dex allows users to trade currencies or other real-world commodities for XRP, or for each other. The Dex contains "autobridging" technology, which automatically connects order books using XRP as an intermediary when it reduces costs. It was this Dex technology that enabled, for example, the creation of a Bullion Exchange in 2014, which used the XRP Ledger to convert gold and precious metals into any currency (discussed in greater detail, below).

43. Decentralized validation. In blockchain, decentralization refers to the transfer of control and decision-making from a centralized entity (individual, organization, or group thereof) to a distributed network. Decentralized networks strive to reduce the level of trust (and thus dependence) that participants must place in each other and deter their ability to exert authority or control over one another in ways that degrade the functionality of the network. In other words, the purpose of decentralized validation is to avoid one party having outsized control over another to make a network decision (to validate a transaction).

44. Since there is no central authority present to validate and verify the transactions, and every transaction in a blockchain is considered completely secured and verified, consensus protocols are a core part of any blockchain network. A consensus mechanism is a fault-tolerant mechanism that is used in computer and blockchain systems to achieve an agreement on a single data value or a single state of the network among distributed processes or multi-agent systems, such as cryptocurrencies. A consensus algorithm is used for all the peers of the blockchain

network to reach a common agreement about the present state of the distributed ledger. In this way, consensus algorithms achieve reliability in the network and establish trust between unknown peers (i.e. distributed validation) in a distributed computing environment. Essentially, the consensus protocol makes sure that every new block that is added to the blockchain is the one and only version of the truth that is agreed upon by all the nodes in the blockchain. While there are different consensus algorithms based on specific objectives such as coming to an agreement, collaboration, co-operation, equal rights to every node, and mandatory participation of each node in the consensus process, they all aim at finding a common agreement that is a win for the entire network.

45. The XRP Ledger's consensus network protocol. To process transactions, the XRP Ledger uses a consensus network of validators. The ledger is standardized with regard to protocols (objectives in the consensus algorithm) and acceptance of validators onto the network, and it is decentralized with respect to how transactions are validated. The latter is the key requirement of the decentralized validation proposition of a blockchain. In addition, Ripple releases a recommended Unique Node List ("UNL") of trusted and verified validators. XRP Ledger users are not required to use these validators for transactions. In addition, validators operate independently without needing to check in with a central system before updating their ledger.

46. The XRP Ledger's consensus protocol breaks up the common notion of a shared set of validator nodes. Rather, it lets every node declare other nodes it subjectively trusts in a UNL. A validator respects only the opinions of nodes in its UNL for validating transactions. Unlike Bitcoin mining, where a single node (by being the fastest miner to solve a numerical problem) wins the right to publish the next block, the entire XRP Ledger "consensus network" participates

in updating the Ledger. The XRP Ledger's network protocol is designed to agree on groups of transactions that are executed as a single unit every four seconds. The number of validators has grown to 150 around the world, including clients, users, and company servers; notable validators include Microsoft and Massachusetts Institute of Technology (MIT).

47. Not all XRP Ledger validators participate in the consensus process all the time. In fact, a smaller subset of validators consistently is responsible for approval of transactions, and serves three functions: it connects to a network of peers, relays cryptographically signed transactions, and maintains a local copy of the complete shared global ledger. What makes an XRP Ledger validator different from other consensus validation protocols is that the validator also issues validation messages, which are sets of candidate transactions for evaluation by the XRP Ledger network during the consensus process.

48. Improved speed of transactions. The features of decentralized validation and the XRP Ledger's consensus protocol enabled an increase in the speed with which it can validate transactions, and make settlement of the transaction faster than traditional payment rails. Further, those transactions can be done not only quickly and cheaply, but also securely given the features implemented on the XRP Ledger. The XRP Ledger can process 1,500 transactions per second with an average ledger settlement (approval time) of 3-5 seconds. This is in comparison to ether, which takes an average of 13 seconds, and bitcoin, which can take around 10 minutes. This speed makes XRP a practical currency for instant transactions in comparison to other leading cryptocurrencies.[27]

49. Improved security. A consensus protocol in a blockchain network must satisfy safety and liveness. Safety means that nothing "bad" ever happens: the ledger does not fork and malicious

[27] *What is the Difference Between Ripple XRP & Other Cryptocurrencies?*, Plus500, https://www.plus500.com/en-US/Instruments/XRPUSD/Difference-Between-Ripple-XRP-Other-Cryptocurrencies~3.

participants cannot double-spend a token. Liveness means that something "good" happens over and over again, so that the network continues to process transactions and makes progress. Violating either property creates trouble for all participants in the network. This has to be a condition for Bitcoin as it is for Ethereum or XRP Ledger or any other blockchain. To prevent malicious activity, each XRP Ledger validator must maintain and have approved a list of trusted servers (the Unique Node List or UNL) with which it compares candidate transactions. The network is designed to rely on trusted validator parties that grow organically, while pushing out dishonest nodes. While validators are not financially rewarded, they are able to vote on updates and have an interest in the success of the network. As a different mechanism from mining, the consensus validator protocol needed to be designed to protect against security vulnerabilities, to instill confidence from users and exchanges. However, what makes the XRP Ledger attractive from a speed and cost perspective also makes it potentially vulnerable if protocol conditions such as the need for synchronized clocks, timely message delivery, the presence of a fault-free network, and an a-priori agreement on common trusted nodes with the UNL are violated. As I will discuss later, the XRP Ledger addressed this security vulnerability using features such as invariant checking to assess incorrect transactions by checking on invalid or corrupt data on the XRP Ledger, as I describe hereafter.

50. Similar to the PoW validation for bitcoin transactions, the XRP Ledger is dependent on the honesty of the majority of the validators, as the system only makes forward progress when a super-majority of the validators each node trusts agree on the state of the Ledger. The concern is what is referred to as the "51% attack scenario," in which a single entity or organization is able to control the majority of the hash rate, potentially causing a network disruption (such as intentionally excluding or modifying the ordering of transactions). Controlling so much of the

network, however, would be expensive and impractical and devalue the currency. Moreover, security issues arising from malicious activity in the XRP Ledger are minimal because hackers would have to simultaneously take control over the majority of nodes on the consensus network – a major challenge given the distribution of over 100 nodes across various organizations and geographical locations.

51. A second security improvement over prior blockchain technology concerns how potential software bugs are treated. The source code for the XRP Ledger is complicated, consisting of many lines. Hence, there is a potential for code to incorrectly execute a transaction.[28] Further (and similar to Bitcoin and other protocols), bugs in the code can be exploited by hackers.

52. The XRP Ledger has an innovative way to address software bugs: a second layer of code, the "invariant checker," runs automatically in real-time after each transaction with the aim to find bugs before they cause any problems in the XRP Ledger. Before a transaction's results are committed to the XRP Ledger, the invariant checker examines those changes for correctness. If the transaction's results break one of the XRP Ledger's strict execution rules, such as creating more XRP (a transaction should only destroy XRP), the invariant checker rejects the transaction. In other words, when the Ledger executes a transaction, it doesn't actually approve a transaction until it runs the invariance checker on a scratchpad that will sum how much XRP disappears and appears. If more XRP appears than disappears, the invariance checker will throw the scratchpad away and create a new scratchpad that basically says the transaction violated a system invariant. The rejected transactions are preserved in the ledger as a permanent record.

53. Environmental improvements. In theory, digital assets and cryptocurrencies were meant to avoid some of the environmental consequences of fiat currencies and their production.

[28] Brad Chase Ethan MacBrough, *Analysis of the XRP Ledger Consensus Protocol*, arXiv:1802.07242v1 [cs.DC] (Feb. 20, 2018).

However, depending on the cryptocurrency and its production and validation protocols, long-term environmental impacts from its energy use are significant. Energy consumption is a critical side effect of blockchain, and as greater adoption and usage of this new technology across a wide range of use cases is expected to scale the need for rapid validation of transactions, the more energy-efficient blockchain technologies have a competitive edge.

54. The XRP Ledger's validation mechanism gives it a competitive edge over Bitcoin and Ethereum. The validation mechanism used by Bitcoin and Ethereum – PoW – is an energy-intensive process to solve computational puzzles. As these puzzles grow more complex, and the price of bitcoin or ether increases due to more demand, the computational power and energy required to solve them increases. The XRP Ledger, in contrast, confirms transactions through a unique consensus mechanism that consumes negligible energy. All XRP that ever will exist is already in existence; as a consequence (and unlike Bitcoin and Ethereum), no unsustainable mining practices or additional energy are ever required to produce more XRP.

55. This is no mere abstraction. A recent comparison report[29] indicated that for every 1 million transactions, the XRP Ledger could power 79,000 lightbulb hours, while Bitcoin could power 4.51 billion lightbulb hours. This means that the energy consumption of XRP is 57,000x more efficient than bitcoin. In these respects, XRP is, as compared to its rivals, an inherently green cryptocurrency.

4. Certain Characteristics Reliably Distinguish Successful Cryptocurrencies From Unsuccessful Cryptocurrencies

56. Since 2009, over 2,000 tokens and coins have disappeared,[30] according to Coinopsy. Moreover, most of the thousands of existing cryptocurrencies have very little value and unclear

[29] Cambridge Bitcoin Electricity Consumption Index, https://cbeci.org/cbeci/comparisons.

[30] John Wanguba, *How Many Cryptocurrencies Have Failed In 2021?*, E-Crypto News, https://e-cryptonews.com/how-many-cryptocurrencies-have-failed/.

potential, and are illiquid (not being traded on exchanges). Some have even been promoted using fraudulent activity. Although this class of assets is relatively new, some factors nevertheless distinguish successful cryptocurrencies from unsuccessful cryptocurrencies. Largely, the criteria align with the strength of the business case that can be made for the coin. 57. For cryptocurrencies to be useful and compete effectively with fiat currencies, platforms must have transaction speeds at least as fast as current systems such as Paypal, Venmo, and Visa. They must also be ready to further scale transaction speeds, and an increase in demand and users. Other characteristics include:

- Value proposition. A cryptocurrency is more likely to achieve wide adoption if it solves a well-understood problem and is coupled to a transparent business model, so the marketplace understands how the cryptocurrency is used and how it creates value.
- Usability and breadth of applicability. A cryptocurrency is more likely to achieve wide adoption if it is easy to use. Cryptocurrencies become easier to use if they are part of a well-developed ecosystem enabling broad applicability – for example, exchanges, ATMs, e-commerce applications, and financial institutions.
- Design. A cryptocurrency is more likely to achieve wide adoption if its design improves on existing currency or a derivative use of that currency. For example, many cryptocurrencies are created in bitcoin's image, but with various adaptations to make them function a little better or worse for different uses. If a given currency's attributes lend itself to being handpicked depending on user priorities (such as security, privacy, anonymity, or speed), it is more likely to succeed.
- Liquidity. Liquidity is typically defined as the ability to trade a large size quickly, and at a low cost. A liquid market is important for trading assets including cryptocurrencies.

- Security Risk. According to the U.S. Federal Trade Commission, in the period from October 2020 through May 17, 2020, "nearly 7,000 people report[ed] losses of more than $80 million on [cryptocurrency] scams."[31]

58. I illustrate the application of these characteristics to bitcoin, ether, and XRP in Table 1:

Table 1. Comparison of features/attributes of top successful cryptocurrencies

Attributes	Bitcoin/bitcoin	Ethereum/ether	XRP Ledger/XRP
Value proposition	Peer-to-peer money transfer; low cost and censorship-proof electronic cash system[32]	Smart contracts for decentralized applications, including in finance (DeFi)[33]	Digital payment network and protocol, functioning as a payment settlement, asset exchange, and remittance system[34]
Usability & breadth of applicability	Mature	Mature	Mature
Design	Store of value and retail payments on a decentralized blockchain	Open decentralized blockchain-based computing platform ether (native currency) is used to pay for transaction fees and computational services	Open decentralized, public blockchain XRP (native currency) is used as a store of value and for payment settlement, asset exchange, and remittance systems
Liquidity	High	High	High
Security risk	Potential transaction malleability vulnerability[35]	Potential reentrancy (double-spend) vulnerability[36]	Potential vulnerability from attacks on specific nodes due to openness and liquidity of system[37]

[31] Emma Fletcher, *Cryptocurrency Buzz Drives Record Investment Scam Losses*, FTC, https://www.ftc.gov/news-events/blogs/data-spotlight/2021/05/cryptocurrency-buzz-drives-record-investment-scam-losses.

[32] *Bitcoin's Unique Value Proposition*, BitMEX, https://blog.bitmex.com/value_proposition/.

[33] *The Ethereum investment Case October, 2021* (June 19, 2020), Ethereumprice, https://ethereumprice.org/guides/article/ethereum-investment-case/.

[34] *6 Popular Altcoins and Their Value propositions*, Finance Monthly, https://www.finance-monthly.com/2021/04/6-popular-altcoins-and-their-value-propositions/.

[35] *Securing Your Wallet*, Bitcoin, https://bitcoin.org/en/secure-your-wallet.

[36] Noama Fatima Samreen & Manar H. Alafi, *Reentrancy Vulnerability Identification in Ethereum Smart Contracts*, https://arxiv.org/pdf/2105.02881.pdf.

[37] MIT Technology Review, *Here's the Biggest Security Threat to the World's Third-Largest Cryptocurrency* (June 16, 2017), https://www.technologyreview.com/2017/06/16/151164/first-large-scale-analysis-of-the-ripple-cryptocurrency-network/.

C. The Cryptocurrency Industry Is Composed of Exchanges, Institutional and Retail Users, and E-Commerce Providers

59. The cryptocurrency industry is composed of custodial and non-custodial stakeholders.[38] Coin issuers, exchanges, corporate users, and retail users are considered custodial: they store and transact on behalf of themselves or third parties. On the other hand, miners, validators, wallet creators, and protocol developers are considered non-custodial: they are responsible for and provide services effectuating transfers of digital assets.

60. I focus here on custodial actors. As stated before, what makes cryptocurrencies effective and successful is that they have high usability (many and scalable use cases with easy access to the currency), as well as that they are becoming a standard in the industry. Much like Bitcoin became the digital peer-to-peer money transfer standard, XRP became a digital standard for currency exchange, asset settlement, and remittances. Usability and standardization require the cryptocurrency to have well-functioning custodial actors, including exchanges, institutional investors such as hedge funds, and e-commerce with viable scalable use cases. Given that the value of cryptocurrencies reflects high usability and increasing standardization, I examine each in turn.

1. Exchanges Facilitate Market Liquidity, Allowing Customers To Trade Cryptocurrencies for Other Assets

61. Cryptocurrency exchanges, also known as "digital currency exchanges" or "crypto exchanges," are essentially businesses that allow customers to trade cryptocurrencies for other assets including conventional fiat money or different digital currencies. They can also be market makers that take bid-ask spreads as transaction commissions for their services or charge fees as a matching platform.

[38] Csilla Brimer, *Response: Custody Rule and Digital Assets*, U.S. Securities and Exchange Commission, https://www.sec.gov/investment/csilla-brimer-response-custody-rule-digital-assets.

62. Cryptocurrency exchanges have become integral to the crypto-asset industry. Cryptocurrency exchanges differ in a number of different ways, including accessibility (licensing and regulation), security (insurance against hacking or fraud, assets held off-line in storage), exchange fees (buyer, seller, currency), liquidity (trading volume), coins offered (top-traded or deep portfolio), educational tools (videos, quizzes, white papers), storage options (exchange instead of wallet), and availability of tax information. Kraken, CoinEgg, Gemini, and Binance are examples of cryptocurrency exchanges or digital marketplaces where market participants can buy and trade crypto. Some, like Coinbase, have been around since the early days of Bitcoin; others, like Robinhood and PayPal, are better-known for other services, and have only recently allowed customers to trade cryptocurrencies within their existing accounts.

63. The importance of liquidity and trading volume on exchanges cannot be overstated. Liquidity attracts users and is a key underpinning of the value of a cryptocurrency.

64. The year 2017 is often regarded as the inflection point for new alternative cryptocurrencies, because the growth, maturity, and security of crypto exchanges facilitated cryptocurrency trading, thus creating liquidity in the market.[39] As of 2017, the top three [cryptocurrency exchanges globally] were Binance (founded 2017), Huobi (founded 2013), and OKEX (founded 2017). While others existed earlier, including Kraken (founded 2011), Coinbase (founded 2012), and bitfinex (founded 2012), most of those earlier exchanges did not report basic information such as the names of the owners, financial data, or even the location of the business, as they were small and privately held. A large crypto exchange, MtGox, had suspended trading and went into bankruptcy proceedings after losses of Bitcoin due to theft, fraud, and mismanagement. Exchanges, which are essentially software platforms, continued to

[39] *A Brief History of Cryptocurrency Exchanges*, https://medium.com/the-capital/a-brief-history-of-cryptocurrency-exchanges-2b48d4531918.

improve their security processes after the MtGox collapse to build confidence in the market and create liquidity. The market capitalization of BTC grew to around $300 billion in 2017. As reported on CryptoCompare as of late September 2021, bitcoin's current market capitalization exceeded $800 billion.

2. High-Volume Trading by Institutional and Retail Users Also Drives Liquidity in the Cryptocurrency Industry

65. Liquidity in crypto exchanges depends on high-volume trading by institutional and retail users alike.

66. To start, institutional investors such as hedge funds, mutual funds, and pension funds who invest on behalf of others long have been and remain key elements of the cryptocurrency market. As noted above, early in the industry's development, few exchanges existed, and very few institutional funds were willing to allocate capital to cryptocurrencies. Early on (before 2017, when exchange-based trading started maturing), crypto asset providers therefore needed to provide incentives to exchanges and guarantees to fund managers as part of their market development strategies.

67. Hedge funds were an early attractive institutional investor in digital assets. Hedge funds have invested in cryptocurrencies since the beginning, and remain a substantial part of the industry: according to one recent estimate, "there are currently between 150 and 200 active crypto hedge funds."[40]

68. Many institutional investors have recently increased their investment in digital assets during the economic effects of the Covid-19 pandemic. In particular, as central banks engage in economic stimulus and lower interest rates, some began to view cryptocurrencies as a good

[40] PricewaterhouseCooper, *3rd Annual Global Crypto Hedge Fund Report 2021* at 8, https://www.pwc.com/gx/en/financial-services/pdf/3rd-annual-pwc-elwood-aima-crypto-hedge-fund-report-(may-2021).pdf.

hedge against corresponding inflation. For example, according to Finoa,[41] a European Union-based digital assets platform, institutional investor growth in cryptocurrencies grew significantly in 2020 and early 2021 (Chart 3):

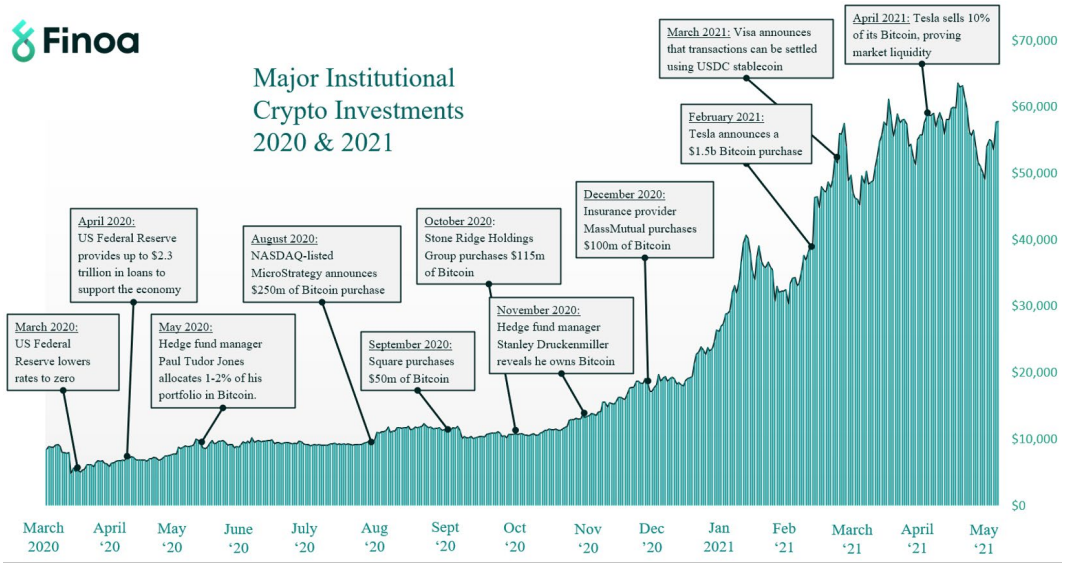

Chart 3. Recent institutional investor growth in cryptoassets

A September 2021 report of a survey of institutional investors from Fidelity Digital Assets found that "52% of investors surveyed globally have an investment in digital assets, with Asia and Europe seeing higher rates of investments than in the U.S."[42]

69. Hedge funds are not the only means by which institutions invest in cryptocurrency-related assets. For example, several crypto-backed Exchange Traded Products (ETPs) are now trading on stock exchanges in Canada and Europe. Further, although the U.S. Securities and Exchange Commission (SEC) has yet to approve a crypto Exchange Traded Fund (ETF), digital

[41] Finoa, *Crypto Space is Developing and Institutional Investors are Getting Involved* (May 27, 2021), https://medium.com/finoa-banking/the-evolution-of-institutional-crypto-investing-43b7289b8528.

[42] Fidelity Digital Assets, *The Institutional Investor Digital Assets Study* at 7 (Sept. 2021), https://www.fidelitydigitalassets.com/bin-public/060_www_fidelity_com/documents/FDAS/2021-digital-asset-study.pdf. "As in previous years, the survey spanned a variety of high-net-worth individuals and institutional investor segments, including financial advisors, family offices, crypto hedge and venture funds, traditional hedge funds, endowments and foundations, as well as pension funds and defined benefit plans." *Id.* at 4.

currency asset managers such as Grayscale have provided an investment avenue for U.S. institutional investors via a trust structure.

70. Retail users, for their part, have increasing options to purchase stock in cryptocurrency companies. Coinbase, one of the largest brokerage exchanges in the space, went public on the NASDAQ via a direct listing in April 2021. Other notable public crypto companies include the crypto miners Canaan and Riot Blockchain, the ETP provider Coinshares, and the holding company Galaxy Digital. Retail users also contribute to liquidity, as a simple statistic from Coinbase illustrates: Although individual purchasers made up just 36% of the exchange's volume during the quarter ending Dec. 31, more than 90% of Coinbase's revenue came from retail trades.[43]

71. In summary, increased involvement of institutional and retail users benefits the liquidity of cryptocurrencies on exchanges and, in turn, increases business opportunities for new startups and corporate use cases. It is important to a given cryptocurrency that both institutional and retail market participants can take advantage of the benefit of liquidity, which is one of the key value propositions of integrating such a cryptocurrency in current and new use case applications.

3. The Existence of Viable, Scalable Use Cases Also Drives Usage of a Cryptocurrency

72. Aside from exchanges and institutional/retail users, the existence of use cases[44] is a key driver for a cryptocurrency to gain traction in the market and become a go-to means to enable payments, a gateway for currency exchange settlements, or other use cases.

[43] Katherine Greifeld & Vildana Harjic, *Plumber Buying Doge Shows Retail Investors' Power in Crypto* (Apr. 18, 2021), https://www.bloomberg.com/news/articles/2021-04-19/plumber-going-all-in-shows-retail-investors-rule-crypto-trading.

[44] Sam Daley, *35 Blockchain Applications and Real-World Use Cases Disrupting the Status Quo* (updated Sept. 16, 2021), Built In, https://builtin.com/blockchain/blockchain-applications.

73. These applications go far beyond the originally envisioned use of a given cryptocurrency and use blockchain technology's ability to create more transparency and fairness in a decentralized way across a wide range of sectors. For example, IBM's Blockchain Platform[45] allows business clients to join an existing blockchain network or work with a client company to create a new blockchain application. With a strong focus on supply chain transparency and intellectual property management, the IBM core applications emphasize industry efficiency use cases.

74. On the other hand, companies such as STL Partners[46] emphasize the design and application of blockchains for digital health applications such as insurance settlements, electronic health records updating, and remote monitoring. The blockchain value in this case is for end-users to reclaim decentralized recordkeeping at a time when technology companies such as Google have been aggregating information.

75. On top of giving end-users more visibility and control over their data, a blockchain's built-in payment mechanisms can enable end-users to sell information in exchange for crypto tokens. To make all this work efficiently and autonomously, artificial intelligence (AI) is integrated on top of the blockchain tracking ledger to curate valuable data sets and match sellers with buyers. Companies such as Fetch.ai, which is traded on Coinbase, are examples of start-ups working on hybrid blockchain systems that integrate recordkeeping with payment mechanisms and artificial intelligence.[47]

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[45] *Blockchain Use Cases*, IBM, https://www.ibm.com/blockchain/use-cases/.

[46] *5 Blockchain Healthcare Use Cases in Digital Health*, STL Partners, https://stlpartners.com/digital_health/5-blockchain-healthcare-use-cases/.

[47] Toby Simpson et al., *Fetch.AI: Token Overview* (Feb. 2019), https://fetch.ai/wp-content/uploads/2019/10/Fetch.AI-Token-Overview.pdf.

76. These are but a few of the myriad examples of commercial uses of cryptocurrencies. Below (Table 2) shows an example classification of a number of commercial uses of cryptocurrencies based on their primary applications. While there is no standardization in the categorization of cryptocurrency applications, the representation captures in my opinion key primary applications intuitively. This is not intended to be advanced as a gold standard, but rather as a broadly used organization of applications.

Table 2. Example Descriptions and Examples of Primary Cryptocurrency Applications

Primary Application	Description	Examples
Payments	Acts as digital cash for e-commerce retailers	Bitcoin, Stellar, XRP
Store of value	Currencies and networks used as a new form of scarce native currency and as a means of settlement	Bitcoin, Litecoin, XRP
Programmable money	Customizable computer code can be designed for specific financial rules and uses	Bitcoin, Bitcoin cash, Litecoin
Stablecoins	Crypto version of fiat currencies tied to the value of an external resource (e.g. $US or gold)	TruUSD, Paxos, Dai, Sologenic
Privacy	Private (anonymous) digital transactions	Monero, Verge, Zcash
Digital ownership	Reframing how we handle, store and monetize data	Bat, Sia, Golem
Decentralized utilities	Crypto-enabled networks, services and products capable of exchanging between the assets issued on the network (predictive markets, currency exchanges, settlements)	Ethereum (decentralized internet); NEO (smart contracts); XRP (bridge currency)
Alternative finance	Crypto assets such as collectibles, commodities, and tokenization of securities	Cryptokitties, Tiberius, Reitium

The fundamental point is this: viable business models that can take advantage of blockchain technology's core characteristics continue to evolve as the open-source software platforms of the major currencies have allowed for uncovering new and potentially successful commercial uses.[48]

D. The Cryptocurrency Industry Is Massive and Dynamic

77. The cryptocurrency industry is today a massive component of the global economy. The valuation of the entire cryptocurrency market recently exceeded $2 trillion.[49] On April 4, 2021, bitcoin alone accounted for $1.1 trillion, but if currencies and applications based on the bitcoin technology such as Bitcoin Cash and Wrapped Bitcoin are included in the market capitalization, the total increases to nearly $1.2 trillion.[50] The remainder of the cryptocurrency market size (capitalization) on April 4th was based on other codebases such as Ethereum ($224 bn.) and the XRP Ledger ($29 bn.).[51]

78. The valuation, liquidity, and supply of cryptocurrencies changes significantly over time. For example, the fifth, sixth, and seventh entities listed on a September 16, 2021 snapshot from Cryptocompare.com's list of the top 10 coins by market capitalization[52] (Chart 4) are recent entrants.

- Solana is a high-performance blockchain founded by former Qualcomm, Intel, and Dropbox engineers that uses a delegated Proof-of-Stake (dPoS) consensus algorithm.

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[48] *The Rise of Using Cryptocurrency in Business*, Deloitte, https://www2.deloitte.com/us/en/pages/audit/articles/corporates-using-crypto.html; *see also Blockchain Use Cases and Applications by Industry*, Consensys, https://consensys.net/blockchain-use-cases/ (categorizing 17 other use cases that make use of "Blockchain technology's core characteristics[:] decentralization, transparency, immutability, and automation").

[49] Arjun Kharpal, *Cryptocurrency Market Value Tops $2 Trillion For the First Time as Ethereum Hits Record High* (Apr. 6, 2021), https://www.cnbc.com/2021/04/06/cryptocurrency-market-cap-tops-2-trillion-for-the-first-time.html.

[50] Gertrude Chavez-Dreyfuss, *Crypto market cap surges to record $2 trillion, bitcoin at $1.1 trillion* (Apr. 5, 2021), https://www.reuters.com/article/us-crypto-currency-marketcap/crypto-market-cap-surges-to-record-2-trillion-bitcoin-at-1-1-trillion-idUSKBN2BS1I7.

[51] Historical Snapshot (Apr. 4, 2021), https://coinmarketcap.com/historical/20210404/.

[52] *Cryptocurrency Prices, Portfolio, Forum, Rankings*, CryptoCompare, https://www.cryptocompare.com/.

The network's value proposition is that it orders transactions to significantly improve their speed and throughput.

- Avalanche is an open-source platform for decentralized finance applications and enterprise blockchain deployments in one interoperable, highly scalable ecosystem. The value proposition for developers who build on Avalanche is to easily create new applications and custom blockchain networks with complex rulesets or build on existing private or public subnets.
- Polkadot has a value proposition to users in that it enables cross-blockchain transfers of any type of data or asset, not just tokens. Connecting to Polkadot gives users the ability to interoperate with a wide variety of blockchains in its network. Hence, governance is a major use, as well as staking (holding or locking cryptocurrencies to support the security and operations of a blockchain network).

#	Coin	Price	Direct Vol	Total Vol	Top Tier Vol	Market Cap		Last 7 Days	24h
1	Bitcoin BTC	$ 47,639.36	$ 638.20 M	$ 7.85 B	$ 7.85 B	$ 896.60 B	B+		-1.21%
2	Ethereum ETH	$ 3,368.92	$ 676.57 M	$ 5.29 B	$ 5.23 B	$ 396.15 B	A-		-2.17%
3	Solana SOL	$ 157.46	$ 840.53 M	$ 2.53 B	$ 2.53 B	$ 79.44 B	C		-2.45%
4	Cosmos ATOM	$ 43.67	$ 77.89 M	$ 1.61 B	$ 1.61 B	$ 11.72 B	C+		11.15%
5	Avalanche AVAX	$ 75.28	$ 4.12 M	$ 1.36 B	$ 1.36 B	$ 29.44 B			7.50%
6	Polkadot DOT	$ 34.13	$ 89.07 M	$ 785.34 M	$ 785.34 M	$ 37.95 B	B		-1.78%
7	XRP XRP	$ 1.069	$ 25.84 M	$ 748.90 M	$ 748.62 M	$ 106.89 B	C+		-0.83%
8	Cardano ADA	$ 2.355	$ 60.02 M	$ 748.83 M	$ 746.04 M	$ 76.24 B	B-		-0.88%
9	OMG Network OMG	$ 9.924	$ 65.70 M	$ 698.75 M	$ 698.75 M	$ 1.39 B	D+		14.38%
10	BUSD BUSD	$ 1.000	$ 1.76 M	$ 631.21 M	$ 631.21 M	$ 12.83 B			0.00%

Chart 4. Snapshot of cryptocurrency market value characteristics (Cryptocompare.com, September 16, 2021)

III. Ripple's Business Model Development Is Consistent With That of a Startup in a High Technology Industry

A. Business Innovation in High Technology Industries Entails an Iterative Process

1. Innovative Applications of Blockchain Technology are Being Developed Iteratively

79. Blockchain technology – that is, the notion of distributed/decentralized ledger technology – has the potential to create new foundations for our economic and social systems. Often referred to as Web 3.0, it represents a decentralized, anonymized, and still-being-defined notion of a future in which "a more semantically intelligent web" leverages data that "will be used by algorithms to improve user experience and make the web more personalized and familiar," and in which users will no longer have to "rely on network and cellular providers that surveil the information going through their systems."[53] For these reasons, it is a technology platform on which new disruptive technologies will be built.

80. But the precise ways blockchain technology will be applied for business purposes are emerging only over time. That is so because the process of adoption – and of developing use cases built on it – is gradual, and necessitates overcoming technological, governance, organizational, and societal barriers.

81. An analogy to the adoption of the protocol that laid the groundwork for the development of the internet, known as TCP/IP (for transmission control protocol/internet protocol), illustrates the point. The TCP/IP protocol first gained traction in around 1983 for a single use (just like blockchain did with Bitcoin): as the basis for e-mail among the researchers on ARPAnet, the precursor to the commercial internet. But a more fundamental feature of the TCP/IP protocol –

[53] USDJ, Cryptocurrency Enforcement Framework, Report of the Attorney General's Cyber Digital Task Force (Oct. 2020), https://www.justice.gov/cryptoreport.

that it permitted users to transmit information digitally by breaking it up into very small packets (each including address information) between nodes in a network – proved to allow for innumerable other, unforeseen commercial applications. Put another way, no one back in 1983 foresaw the degree to which the Internet would become a common way to stream television shows or meet people to date socially. That disruption and innovation of many industries flowed from the "TCP/IP" protocol, a significant technological innovation of years earlier. Many applications of the technology developed only over time, by a trial-and-error process of building scale and adoption sufficient to overcome the incumbent networks and service providers of the day.

82. Once the basic infrastructure of the web gained critical mass, however, a new generation of tech companies took advantage of low-cost connectivity by creating internet services that were compelling substitutes for existing businesses. Many companies failed during the first few decades, until sustainable businesses with good business models were built. Ultimately, it took more than 30 years for TCP/IP to move through all the phases – from a single use case to broader disruptive business models leading substitution of existing businesses, to the transformation of how companies create and capture value – by which it reshaped the economy.

83. Blockchain technology is in the early stages of that same process. In the case of blockchain, the principal incumbent networks are those of banks and other contractual validation parties that have overseen business-to-business, business-to-consumer, and peer-to-peer transactions (in some cases, for centuries). Successful high-tech companies building applications for blockchain technology have to contend with structural, cultural, and governance barriers like those that Internet TCP/IP-based companies had to contend with when they were building scale and adoption. But the low cost, high speed, automated validation promise of blockchain

technology is leading to all the applications/use cases we now call the blockchain/cryptocurrency/digital asset industry. Further, the technology companies that are driving innovation in the blockchain-technology space tend to move through an iterative innovation cycle familiar from companies that drove innovation during the internet era. I address that cycle next.

2. A High-Tech Business's Initial Value Proposition Will Change Over Time in Response to Customer (Market) Input

84. Building a high-tech business is risky. An organization's success depends on its ability to innovate – either to stay in the market, gain competitive advantage, gain market share, or ultimately generate revenue. Many new products fail long before launch for technical reasons or for not finding the right value proposition for the intended users or market segments. Within a firm, the process flow of innovation tends to result in significant attrition: according to one estimate, for every 7 new product ideas, about 4 enter development, and 1.5 are launched.[54] Once launched in the market, the product attrition rate is even higher. One study has shown that out of approximately 30,000 products introduced each year, 95% fail, because of lack of (among others) scalability of product adoption, competition from incumbents, or from other startups.[55] Another study has shown that it will require on average four to six iterations on business model and product offerings for a startup to establish a toe-hold in the market and be able to scale through customer adoption.[56]

[54] *7 Reasons Why Innovation Fails in Organizations*, IdeaPoke, https://www.ideapoke.com/growthleader/reasons-innovation-fails/#:~:text=According%20to%20process%20expert%2C%20Robert,the%20product%20success%20rate%20is.

[55] Marc Emmer, *95 Percent of New Products Fail. Here Are 6 Steps to Make Sure Yours Don't* (July 6, 2018), Inc., https://www.inc.com/marc-emmer/95-percent-of-new-products-fail-here-are-6-steps-to-make-sure-yours-dont.html.

[56] Scott Shane, The Illusions of Entrepreneurship: The Costly Myths that Entrepreneurs, Investors and Policy Makers Live by (Yale University Press 2008).

85. Since the 1970s, there have been numerous studies into why certain high-tech businesses succeed while others fail. Needless to say, fulfilling basic functional and utilitarian needs is the minimal requirement of any product. On occasion, considerations such as whether a product can enhance the buyer's reputation or reduce risks play a large role in some business-to-business (B2B) purchases. But the number one reason for success is delivering a superior value proposition to the customer – in other words, a product or service that delivers a superior benefit over the incumbent solution.

86. One fundamental challenge for a great high-tech company is to anticipate future customer needs that the customer itself may not know it has better than the competition. This is challenging because typical consumers, being limited by their own experience, often cannot imagine what they don't know about emerging technologies and how those technologies might create novel solutions to problems consumers might not know they have.

87. For these reasons, a truly disruptive high-tech company (particularly one that sells technology-driven products) often focuses on acquiring significant input from early and influential users. This requires proactive engagement with new customers through innovative marketing strategies. Those strategies might include selling products at 100% discount, or by reaching out to different types of customers to have them try the product. I will discuss these strategies in more detail in Part III.D.

88. Having received consumer input in this way, high-tech companies often go through many iterations to try and meet the user or customer's objectives. To succeed, the firm must clearly define and articulate its product's value proposition and ensure that customers recognize it as such. For example, although Facebook was launched in early 2004, it introduced Facebook Ads

three years later, in 2007;[57] today, virtually all of its revenue comes from advertising sales. For another example, Salesforce started in 1999 as an internet company for customer relationship management, a value proposition that was easy to copy in the early dot com days. The company therefore grew as quickly as possible to establish itself as a first mover (signing on many clients and partners), then shifted from a software to an on-demand services firm.[58,59] This allowed it to offer an AppExchange for third parties to build applications for SalesForce clients.[60]

3. A High-Technology Startup's Business and Revenue Model Also Will Change Over Time, Often Over Several Years

89. Many startups initially are not sure where the revenue for their business is going to come from. They may have a hypothesis in a business plan, but if the value proposition is unclear, and the required partnership needs of the business ecosystem either don't yet exist or are strong incumbent companies, a lot of the business is done "at risk" (i.e. without being paid).

90. This is particularly the case for high tech businesses. Their products are highly dependent on continued investment in innovation research and development. This investment allows the companies to integrate the latest technologies or algorithms and fight off competition, while seeking to deploy software-as-a-service (SaaS) business models common to the fintech and other high-tech space. Service or license fees alone may not cover costs, requiring companies to constantly search for new revenue streams as they build out their product portfolio. In the

[57] *See* Facebook Unveils Facebook Ads (Nov. 6, 2007), Facebook, https://about.fb.com/news/2007/11/facebook-unveils-facebook-ads/.

[58] David B. Yoffie, Alison Berkley Wagonfeld (2005). *Oracle vs. salesforce.com.* Harvard Business School case. The case explores the phenomenon of software becoming a service as Salesforce.com leads customer relationship management (CRM) solutions as a Web-based service.

[59] Antonio Davila and Jeffrey Eisen (2003). *Salesforce.com. The Evolution of Marketing Systems*. Stanford Graduate School of Business Case E-145. The case discusses how Salesforce.com evolved from a fledgling start-up to a leader in the provision of Web-based management systems.

[60] *SalesForce What is Appexchange?*, https://developer.salesforce.com/docs/atlas.en-us.appExchangeInstallGuide.meta/appExchangeInstallGuide/appexchange_install_whatis.htm.

technology and market de-risking phases of a company's life cycle, a combination of equity investor capital and customer purchases of product are often used to "pay the bills."

91. Several examples prove the point. Twitter revenue derives most of its revenue today from the sale of advertising services.[61] However, initially the company had no advertising platform, and had to cover its costs to build this asset by deploying capital from its investors. The impact of this product development cycle, and building its advertising revenue model,[62] is that Twitter, founded in 2007, was not profitable until 2019, 12 years later.[63] Square, a financial services and online payments company founded in 2009,[64] generates revenue through its CashApp and software licenses and only recently turned a profit.[65] Tesla's business model, based on selling cars or energy storage devices with associated services, did not turn a profit until it started selling carbon offsets from its electric vehicles and storage to other carbon-intensive companies.[66] After July 21, 2021, the company turned a profit even without the emission credits. Common to all these tech company business and revenue models is that they did not become profitable (revenue did not cover costs) until recently: 18 years after Tesla's incorporation, 12 years after Twitter's founding, and 12 years after Square was launched.

92. It should not be expected that digital asset companies are quickly profitable either. The history of other high-tech businesses shows there would be nothing unusual about a digital asset

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[61] Mansoor Iqbal, *Twitter Revenue and Usage Statistics (2021)* (July 5, 2021), https://www.businessofapps.com/data/twitter-statistics/.

[62] Jack Marshall and Yoree Koh, *The Problem With Twitter Ads* (Apr. 30, 2015), https://www.wsj.com/articles/the-problem-with-twitter-adsthe-problem-with-twitter-ads-1430438275.

[63] Seth Fliegerman, *Twitter records its first annual profit, but it is losing millions of users* (Feb. 7, 2019), CNN Business News, https://www.cnn.com/2019/02/07/tech/twitter-earnings-q4/index.html.

[64] *How Square Became a $30 Billion Company by Reimagining Payments*, https://producthabits.com/how-square-became-a-30-billion-company-by-reimagining-payments/.

[65] Nathan Reiff, *How Square Makes Money* (Feb. 26, 2021), Investopedia, https://www.investopedia.com/how-square-makes-money-4801197.

[66] Jay Ramey, *Tesla Made More Money Selling Credits and Bitcoin Than Cars* (Apr. 7, 2021), https://www.autoweek.com/news/green-cars/a36266393/tesla-made-more-money-selling-credits-and-bitcoin-than-cars/.

firm's technology development cycle being out of synch with scalability of market adoption, or about that condition continuing for a decade or longer.

4. A High-Technology Startup Must Adopt Entrepreneurial Market Practices To Overcome Technological, Governance, Organizational, and Even Societal Barriers to Scale

93. A key characteristic of a high-technology company's lifecycle is the need for rapid growth for adoption of its product. The reason is that technology innovation cycles are short, and competition is fierce to displace the innovation. Thus, tech companies will deploy aggressive product marketing and pricing strategies for optimal and rapid scaling, and adoption, of their product.

94. Product pricing, like a value proposition and identification of the customer's reason to buy or engage, starts with a hypothesis. The more educated and research-backed it is, the more likely it will be valid. Even then, it is as much an art as a science.[67] The perceived value from a product simply answers how much value the customer feels a product delivers for the price they pay in comparison to the competition. A tech company's product is perceived to be valuable if the value the customer perceives is higher than the price they would pay.

95. The bigger the difference, the more valuable a product appears.[68] In theory, this can mean three things. The company can either lower the price, or increase the value, or do both. In most cases, the company should be focused on figuring out what in the product the customer feels is important and is worth the investment such that it becomes a buying decision they cannot refuse, even at a higher price.

[67] The Art and Science of Pricing, https://bus-ex.com/article/art-and-science-pricing.

[68] Abdo Riani, *How To Price Your Early Stage Startup Product* (July 29, 2020), Forbes, https://www.forbes.com/sites/abdoriani/2020/07/29/how-to-price-your-early-stage-startup-product/?sh=7a3a8ca5203e.

96. *Acquisition of customers is expensive.* As part of price discovery, tech companies offer major discounts to get traction in the market, including paying clients to try out a product. For example, in software product offerings, it is common to use multiple strategies including pricing at a discount relative to competition, offering the product for free, providing grandfathered pricing for long-time customers or providing exclusive benefits, and making customers pay only if the company delivers value.[69] Often this is referred to as influence spreading by providing discounts to customers, particularly if users are connected in a network, in the hope of maximizing the influence spread.[70] Well-known tech companies that have deployed one or more of these discounting strategies before they became established, and their value proposition became accepted by the market, include Netflix, Lending Club, LinkedIn and others.

97. These discounting practices also yield information the business may find useful in deciding what it can charge for its products. Initially, a business cannot know what price a given product (an iPhone, a Tesla, a LinkedIn subscription, or Twitter advertising) can command because its perceived value is not known, and many different types of customers value different attributes. A Tesla buyer who wants the car as a differentiated tech toy that few other people can afford will pay $120,000, while a Tesla buyer who focuses on the environmental value will pay $35,000. Square Free licenses are free for single locations, and Square Plus cost $60 for advanced inventory services per location. Twitter advertising costs depend on ad type, which includes promoted tweets, promoted accounts, and promoted trends. Promoted tweets cost $0.50 to $2.00 for each action. Promoted accounts cost $2 to $4 for each follow. Promoted trends cost $200,000 per day. Pricing strategy therefore emerges as part of the iterative business-model

[69] *5 Tips to transition From A Free To A Paid Service* (June 13, 2010), TechCrunch, https://techcrunch.com/2010/06/13/free-to-paid-tips/.

[70] Yu Yang et al., *Continuous Influence Maximization: What Discounts Should We Offer to Social Network Users?*, SIGMOD'16, June 26-July 01, 2016, San Francisco, CA, USA DOI, http://dx.doi.org/10.1145/2882903.2882961.

development process I described above: Incentivizing potential buyers with discounts and maximizing influence spread to other customers ultimately helps stabilize the price.

98. It is critical to understand that whether a product's price covers its development costs is initially a secondary consideration for technology startups. Acquisition of customers and users, and investment in the buildout of an ecosystem of operations are the primary goals. It is for this reason that most startup companies – while revenue-positive – are not profitable until years after their founding, once sufficient customers or users have been acquired. So it is not expected for a tech startup's revenue to cover its operational costs until a decade after starting operations.

99. The fintech industry is no different. Most of the top fintech companies – including Stripe, Tink, and Klarna – were not overnight successes, but were founded in the early 2010s. Since then, through discounted product offerings and other customer acquisition strategies detailed earlier, they are only now starting to become profitable.[71]

B. Ripple's Funding and Development of a Commercial Application for XRP and the XRP Ledger Are Consistent with That of a Startup in a High-Technology Industry

1. Ripple's Vision To Transform Transaction Settlements with an Innovation That Leverages XRP and the XRP Ledger

100. Company Vision. The initial target market of Ripple was to develop a global payments network for international currency transfers and settlements. This was part of a broader vision to develop an "Internet of Value," rethinking the cultural value of money.[72] Value should be exchanged as easily as information. Although information moves around the world instantly, a single payment from one country to another is slow, expensive, and unreliable.

[71] *Investment in Fintech Booms as Upstarts Go Mainstream* (July 15, 2021), The Economist, https://www.economist.com/finance-and-economics/2021/07/15/investment-in-fintech-booms-as-upstarts-go-mainstream.

[72] Ludovico Rella, *Steps towards an ecology of money infrastructures: materiality and cultures of Ripple*, Journal of Cultural Economy, Vol. 13, No. 2, 236-249 (Jan. 8, 2020), https://doi.org/10.1080/17530350.2020.1711532.

101. Worldwide, cross-border payments are expected to reach $156 trillion in 2022, with a combined cost of nearly $10 trillion a year (assuming the global average cost of 6.5% to send funds) – so called "friction cost" between parties, counterparties and intermediaries.[73] The process of international settlements can take as many as 14 independent steps and the time frame for clearing and settlement of a transaction is generally referred to as "T+3" – that is, three days after the trade (T), the transaction is settled. However, some transactions involve so much friction that they can take weeks to settle.[74] Ripple sought to reduce these friction costs by enabling participants to message, clear, and settle transactions at low cost and high speed. With the Internet of Value, a value transaction such as a foreign currency payment, can happen instantly, just as how people have been sharing words, images, and videos online for decades.

102. The Innovation. Before the launch of Ripple's products, which were built leveraging the open-source XRP Ledger and its native currency, XRP, sending money globally traditionally involved using SWIFT, a service that allows banks to send messages with payment information. Once the payment is confirmed, manual input is required to transfer the funds. If the transacting banks do not have an existing relationship, the funds are routed through intermediary banks. Since each intermediary charges fees for its transaction services, the costs of an international settlement can have unexpected fees and delays.

103. A blockchain transaction settlement solution securely and transparently combines the two-step process of messaging and fund transfer in one transaction and reduces the friction costs of intermediaries. This type of digital innovation for global settlements between banks – for

[73] Suman Bhattacharyya, *Fintechs attack cross-border business payments as banks and legacy players rush to innovate* (May 25, 2021), PaymentsDive, https://www.paymentsdive.com/news/fintech-cross-border-banks-coopetition-american-express-ripple-zelle-venmo/600729/.

[74] Florian Seeh, *How new entrants are redefining cross-border payments* (Feb. 23, 2021), EY, https://www.ey.com/en_us/banking-capital-markets/how-new-entrants-are-redefining-cross-border-payments.

business-to-business transactions – is much like Bitcoin's blockchain technology for business-to-customer and customer-to-customer payments by replacing banks as trusted verifiers.

2. Ripple's Funding by Equity Investment Rounds Based on Ripple's Vision

104. To contextualize how Ripple acted on the foregoing vision, it is useful to consider first Ripple's early equity investment rounds. The objective of equity investments is to (i) build and scale companies into platformizable solutions that can compete with and replace incumbents, while at the same time (ii) increase the valuation of the invested companies over multiple rounds, resulting in high returns from exits. On average, equity investors invest in one out of 200 businesses they receive proposals from, because they seek high-value exits (such as acquisitions or Initial Public Offerings (IPOs)). That in mind, the type of investor syndicate that values and invests in companies is informative: such syndicates bring experience, strategic management direction, and access to clients or partners. Further, equity investment (particularly from well-recognized funds) can indicate marketplace perceptions of the value of the vision of the company – often based on a robust understanding of the industry.

105. As Chart 5 shows, Ripple participated in multiple investment rounds since 2013 from syndicates of well-recognized and successful venture capital and growth equity investors:

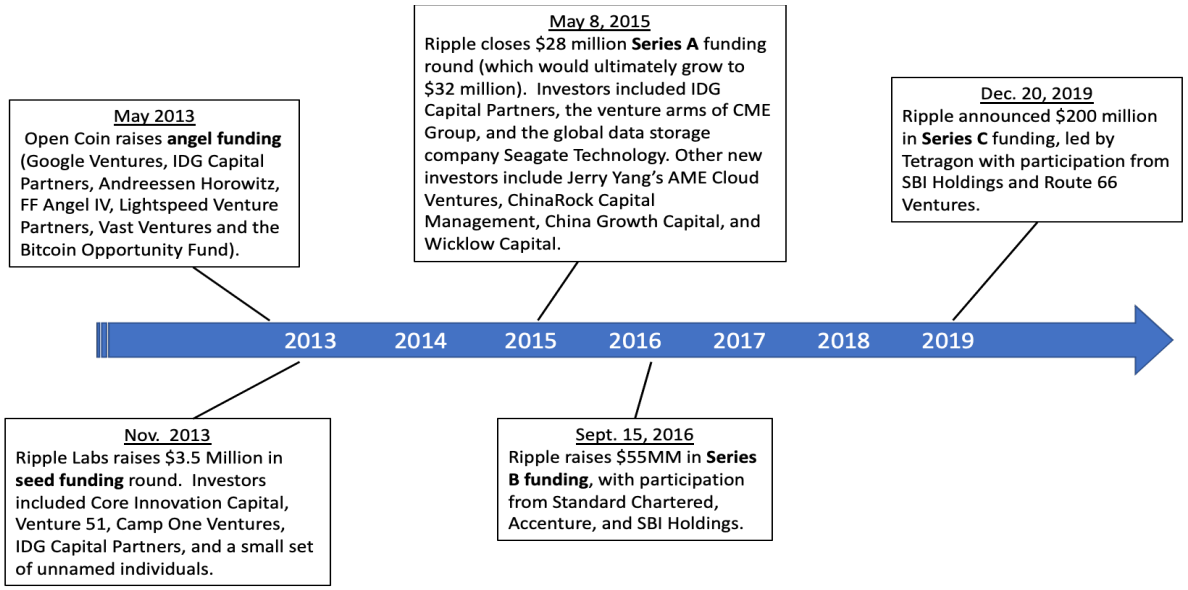

Chart 5. Equity investment rounds in Open Coin/Ripple[75]

That Ripple received investments from the entities set forth in Chart 5 indicates that the marketplace viewed Ripple's vision to build a global payments settlement platform on the blockchain, using a cryptocurrency that could serve as a bridge currency, as a high-value opportunity. Since the business model of SWIFT and the fee structure of banking intermediaries in global settlements was known to face speed and efficiency challenges, the future valuation of Ripple, if successful, was viewed to become a high multiple of the equity investment committed to the company.

[75] Shirley Siluk, *Google Ventures Invests in Bitcoin Competitor OpenCoin* (May 14, 2013), CoinDesk, https://www.coindesk.com/google-ventures-invests-in-bitcoin-competitor-opencoin; Monica Long, *Ripple Labs Raises $3.5 Million in New Investment Round* (Nov. 12, 2013), https://ripple.com/insights/ripple-labs-raises-3-5-million-in-new-investment-round/; Team Ripple, *Ripple Labs Closes $28 Million Series A Funding Round* (May 18, 2015), https://ripple.com/ripple_press/ripple-labs-closes-28-million-series-a-funding-round/; Jeff John Roberts, *Ripple Just Raised $55 Million and Signed on These Major Bank Partners* (Sept. 15, 2016), Fortune, https://fortune.com/2016/09/15/ripple-raises-55m-adds-major-bank-partners-as-blockchain-gains-ground/; *Ripple Caps Record Year With $200 Million Series C Funding* (Dec. 20, 2019), Ripple, https://ripple.com/insights/ripple-caps-record-year-with-200-million-series-c-funding/.

106. The investments included (but were not limited to) two unpriced early-stage investment rounds and three priced rounds.[76] Unpriced rounds, typically used when the company is pre-revenue, are often structured as convertible notes. These equity instruments are contractually set up to convert to stock for investors at a discount on the valuation given at the time of the next priced round. I indicate this in Table 3 below, where the 2013 seed round converts to equity once a revenue target is reached (in this case $1 million). The early-stage unpriced round investments convert to equity at a 50% discount on the share price as compared to the price of the A round valuation ($1.78/share).

107. Since Ripple is an equity-invested company, product development and market adoption strategies are central to the expectation of increasing market valuation. As is typical of equity investment rounds, each priced round will have milestone expectations associated with the investment. These are intended to make sure the company makes progress in securing market validation of its business hypothesis and vision and is well-positioned to acquire users or customers for its growth expansion. Design, development, product iteration or pivoting, and testing of products under real-world conditions are traditional investor expectations, as are growth strategies to acquire and scale customers.

108. The milestones Ripple was to meet are consistent with these expectations. I provide examples of these expectations in Table 3, along with the share price at the time of each of these rounds:

[76] I have focused on these dimensions of Ripple's funding because they are reflected in its Consolidated Financial Statements, as addressed in Table 3.

Table 3. Ripple investment rounds, investor expectations and share prices[77]

	Amount, $ MM	Milestone Expectations	Share Price, $
Unpriced early-stage round (2013)	NA	NA	Par value (0.0001)
Unpriced early-stage round (2013)	3.5	Notes convert to equity once $1M in revenue is reached	0.92
A Round (2015)	32	Completion of the "design, development and testing of the Product" and the distribution of sales and marketing materials for the product At least one financial institution client; real customer data	1.78
B Round (2016)	55	Amendment of Series A milestones to two financial institution clients using certain Ripple technology in a live environment by April 30, 2016	3.81
C Round (2019)	200	Not disclosed in consolidated financial statements	61.48

109. The escalation (increase) in price indicates that Ripple met or exceeded investor expectations and that market validation of the value proposition was yielding results. The share price doubled between the A and B rounds and commanded a 16x multiple between the B and C rounds. These share prices are not based on free trading since the company is private but are the result of negotiations among the investor syndicates and founders between rounds, comparisons

[77] Milestone expectations and share price data from Ripple Labs Inc. Consolidated Financial Statements for fiscal years ending in 2014, 2015, 2016, 2017, 2018, 2019, and 2020 referred to in Materials Considered (Appendix B); Dan Illett, *Meet the money behind bitcoin competitor OpenCoin* (Apr. 16, 2013), CoinDesk, https://www.coindesk.com/markets/2013/04/16/meet-the-money-behind-bitcoin-competitor-opencoin/; Monica Long, *Ripple Labs Raises $3.5 Million in New Investment Round* (Nov. 12, 2013), Ripple Insights, https://ripple.com/insights/ripple-labs-raises-3-5-million-in-new-investment-round/; Team Ripple, *Ripple Labs Closes $28 Million Series A Funding Round* (May 18, 2015), Ripple, https://ripple.com/ripple_press/ripple-labs-closes-28-million-series-a-funding-round/; Jeff John Roberts, *Ripple Just Raised $55 Million and Signed on These Major Bank Partners* (Sept. 15, 2016), Fortune, https://fortune.com/2016/09/15/ripple-raises-55m-adds-major-bank-partners-as-blockchain-gains-ground/; Team Ripple, *Ripple Caps Record Year With $200 Million Series C Funding* (Dec. 20, 2019), Ripple Insights, https://ripple.com/insights/ripple-caps-record-year-with-200-million-series-c-funding/.

to public proxy companies, as well as anticipated valuations in upcoming rounds and at the time of exit.[78]

110. Separate from its equity investment, I understand that Ripple distributed XRP to an array of counterparties with the goal of increasing liquidity in the market.[79] Such distributions are fully consistent with the methods of product adoption of high-technology companies identified above and the milestone expectations of Ripple's equity investments. For Ripple to fully capitalize on the XRP Ledger's capabilities to undergird a blockchain-based solution to settle international transactions – and so to deliver on the expectations of its equity investors – it was necessary for there to exist sufficient liquidity to support those transactions.[80] From the point of view of high-technology entrepreneurship, Ripple's distributions of XRP for the purpose of building liquidity are therefore helpfully understood as the blockchain-context equivalent of distributions (sales) of inventory as a means to promote product adoption, as I describe in paragraph 111. As explained above in Part III.A, innumerable other technology firms have employed that strategy to great success.

111. I further understand that Ripple at times sold XRP at a discount from prevailing market prices. As explained above, however, that is also consistent with common marketing strategy for startups in high-technology industries looking to encourage adoption of their products. The practice of selling inventory (here: XRP) to support a healthy market for Ripple's products (here: international settlements), and sometimes doing this at a discount, is analogous to loss leader pricing or penetration pricing market strategies. These strategies are championed by many

[78] Staff writer, *Managing Risk Through the Use of Milestone-Based Conversion Rate Adjustments* (May 1, 2004), Venture Capital Journal, https://www.venturecapitaljournal.com/managing-risk-through-the-use-of-milestone-based-conversion-rate-adjustments/.

[79] In re: Ripple Labs Inc. Wells Submission on Behalf of Ripple Labs Inc.

[80] D.B. Yoffie and G. Gonzales, *Ripple: The Business of Crypto* (Feb. 18, 2020), Harvard Business School.

early-stage startups or companies to build a vital user base for the core product (here: use of XRP to settle transactions) and attract a few high-profile users and win business transactions on a larger scale.[81] By this practice, the purpose of XRP sales and making attractive price adjustments for certain market participants is to draw new users to secure recurring revenue in the future for Ripple's global transaction settlement products, which use XRP to function on the ledger. Hence, Ripple had to adopt a penetration market sales strategy to enable the liquidity to scale and address the global settlements market opportunity. Examples we are all familiar with include Google's offering of free Gmail to remove barriers to customers adopting the entire Google G Suite. Or Disney offering Disney+ at discounted rates to customers to compete against Netflix, but in the process draw viewers to Hulu and ESPN+. Similarly, cell phones are priced attractively, while telecommunications companies scale their revenue on data plans.

3. Ripple's Iterative Development of Software Products Using the XRP Ledger and XRP Exemplifies How High-Technology Companies Develop Products Using Innovative Technologies

112. The history of Ripple's product design and rollout to the market reflects a go-to-market roadmap influenced by technological innovation, market feedback, and societal change and trust in the use of digital solutions. In particular, as noted above, technology startups such as fintech companies need to show their equity investors a path to market for the new technology and a viable business model that can generate revenue for the company and result in increased valuations. Therefore, Ripple benefitted from an iterative process by which it experimented with means that would demonstrate the utility of its technology in service of its broader business premise.

[81] *Loss Leader Pricing: A Comprehensive Review for Startups* (Feb. 3, 2020), Brex, https://www.brex.com/blog/loss-leader-pricing/.

113. I show examples of Ripple's product rollout and marketing strategies in Chart 6.[82] The Chart illustrates the timeline of Ripple's product-portfolio buildout, from software distribution to marketing of cross-currency protocols, and release to clients of the multi-functional RippleNet Product Suite, including the On-Demand Liquidity product.

[82] Danny Bradbury, *Ripple Labs now taking cash payments following deal with ZipZap and SnapSwap* (Oct. 8, 2013), CoinDesk, https://www.coindesk.com/ripple-labs-now-taking-cash-payments-zipzap-snapswap; Monica Long, *RippleCharts Revamp* (Feb. 10, 2014), Ripple Insights, https://ripple.com/insights/ripplecharts-revamp/; Team Ripple, *Introducing the New Ripple Trade Client* (July 7, 2014), Ripple Insights, https://ripple.com/insights/introducing-the-new-ripple-trade-client/; Team Ripple, *A New Chapter for Ripple* (Oct. 6, 2015), Ripple Insights, https://ripple.com/insights/a-new-chapter-for-ripple/; Monica Long, *New Ripple Settlement and FX Solutions Lower the Total Cost of Settlement for Banks and Their Customers* (Oct. 6, 2015), Ripple, https://ripple.com/ripple_press/new-ripple-settlement-and-fx-solutions-lower-the-total-cost-of-settlement-for-banks-and-their-customers/; Team Ripple, *Ripple Strikes Multi-National Deal with SBI Holdings to Meet Growing Demand for Ripple Solutions Across Asia* (Jan. 28, 2016), Ripple Press, https://ripple.com/ripple_press/ripple-strikes-multi-national-deal-with-sbi-holdings-to-meet-growing-demand-for-ripple-solutions-across-asia; Asheesh Birla, *Ripple's Product Suite is Growing* (July 31, 2017), Ripple Insights, https://ripple.com/insights/ripples-product-suite-growing/; HODL Daily Staff, *Confirmed: Ripple Says Major Rebranding Underway, XRP-Powered xRapid Transforming to On-Demand Liquidity* (Oct. 11, 2019), The Daily HODL, https://dailyhodl.com/2019/10/11/confirmed-ripple-says-major-rebranding-underway-xrp-powered-xrapid-transforming-to-on-demand-liquidity.

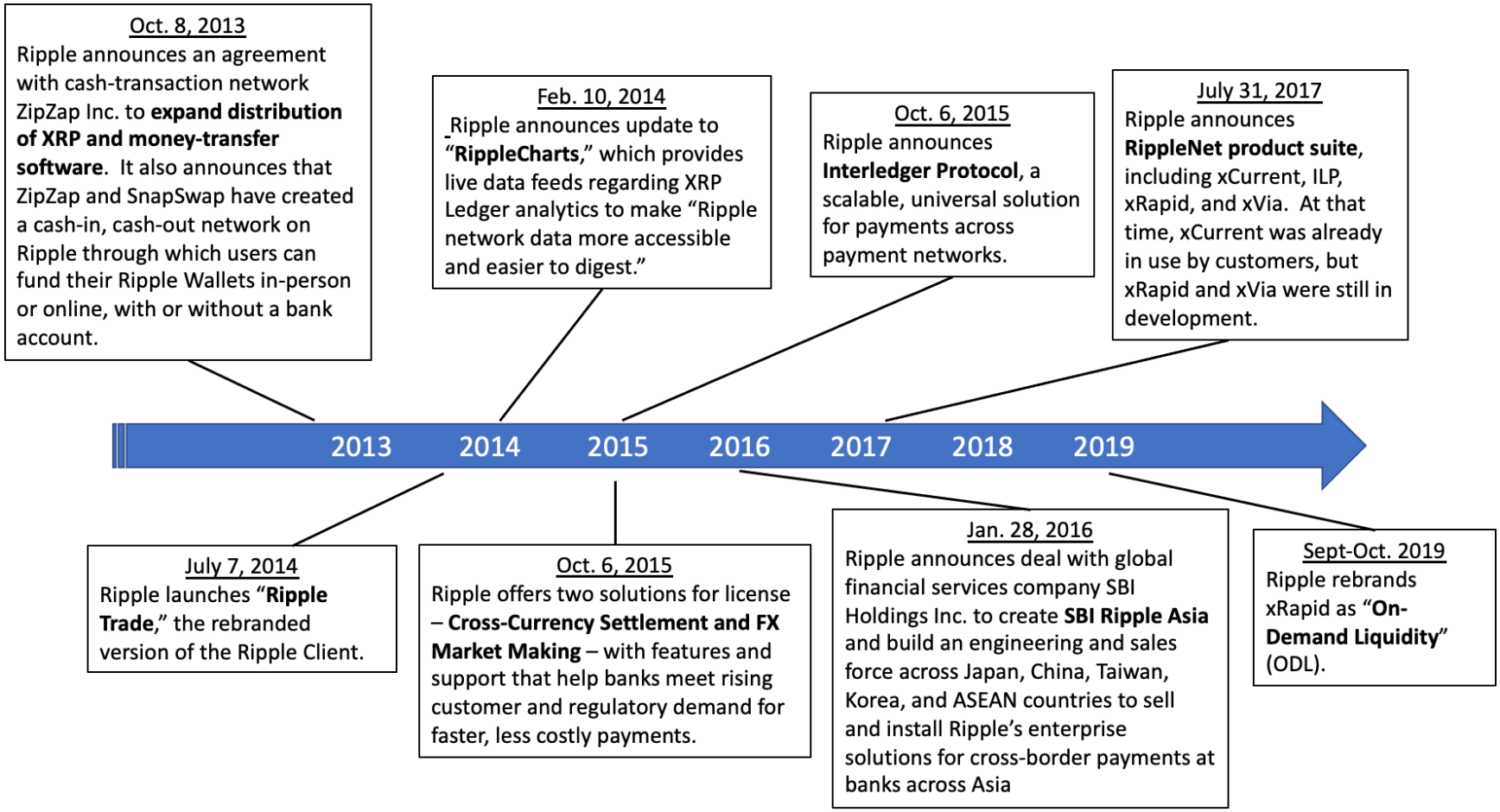

Chart 6. Timeline history of product design and rollout to the markets

114. Further, in Chart 7, I show a timeline of examples[83] of the history of commercial adoption of Ripple's products, with new partners and customers as the product portfolio evolves.

[83] Danny Bradbury, *Ripple Labs now taking cash payments following deal with ZipZap and SnapSwap* (Oct. 8, 2013), CoinDesk, https://www.coindesk.com/ripple-labs-now-taking-cash-payments-zipzap-snapswap; Jon Southurst, *Bullion Exchange Brings Ripple into the Physical World* (Jan. 31, 2014), Coindesk, https://www.coindesk.com/bullion-exchange-brings-ripple-physical-world; Pete Rizzo, *Fidor Becomes First Bank to Use Ripple Payment Protocol*, (May 4, 2014), CoinDesk, https://www.coindesk.com/markets/2014/05/05/fidor-becomes-first-bank-to-use-ripple-payment-protocol/; Team Ripple, *A Debit Card Powered by Ripple* (Aug. 13, 2014), Ripple Insights, https://ripple.com/insights/a-debit-card-powered-by-ripple/; Team Ripple, *Ripple Labs and Earthport Announce Global Partnership* (Dec. 3, 2014), Ripple Insights, https://ripple.com/insights/ripple-labs-earthport-announce-global-partnership/; Team Ripple, *Seven Leading Banks Join Ripple's Global Network* (June 22, 2016), Ripple Insights, https://ripple.com/insights/seven-leading-banks-join-ripples-global-network/; Team Ripple, *American Express Joins RippleNet – Giving Visibility and Speed to Global Commercial Payments* (Nov. 16, 2017), Ripple Insights, https://ripple.com/insights/american-express-joins-ripplenet-giving-visibility-and-speed-to-global-commercial-payments/; MoneyGram, *MoneyGram Announces Strategic Partnership with Ripple* (June 17, 2019), MoneyGram, https://ir.moneygram.com/news-releases/news-release-details/moneygram-announces-strategic-partnership-ripple; Nikhilesh De, *Euro Exim Bank Taps Ripple's xRapid for Cross-Border Settlements* (Jan. 8, 2019), CoinDesk, https://www.coindesk.com/euro-exim-bank-taps-ripples-xrapid-for-cross-border-settlements.

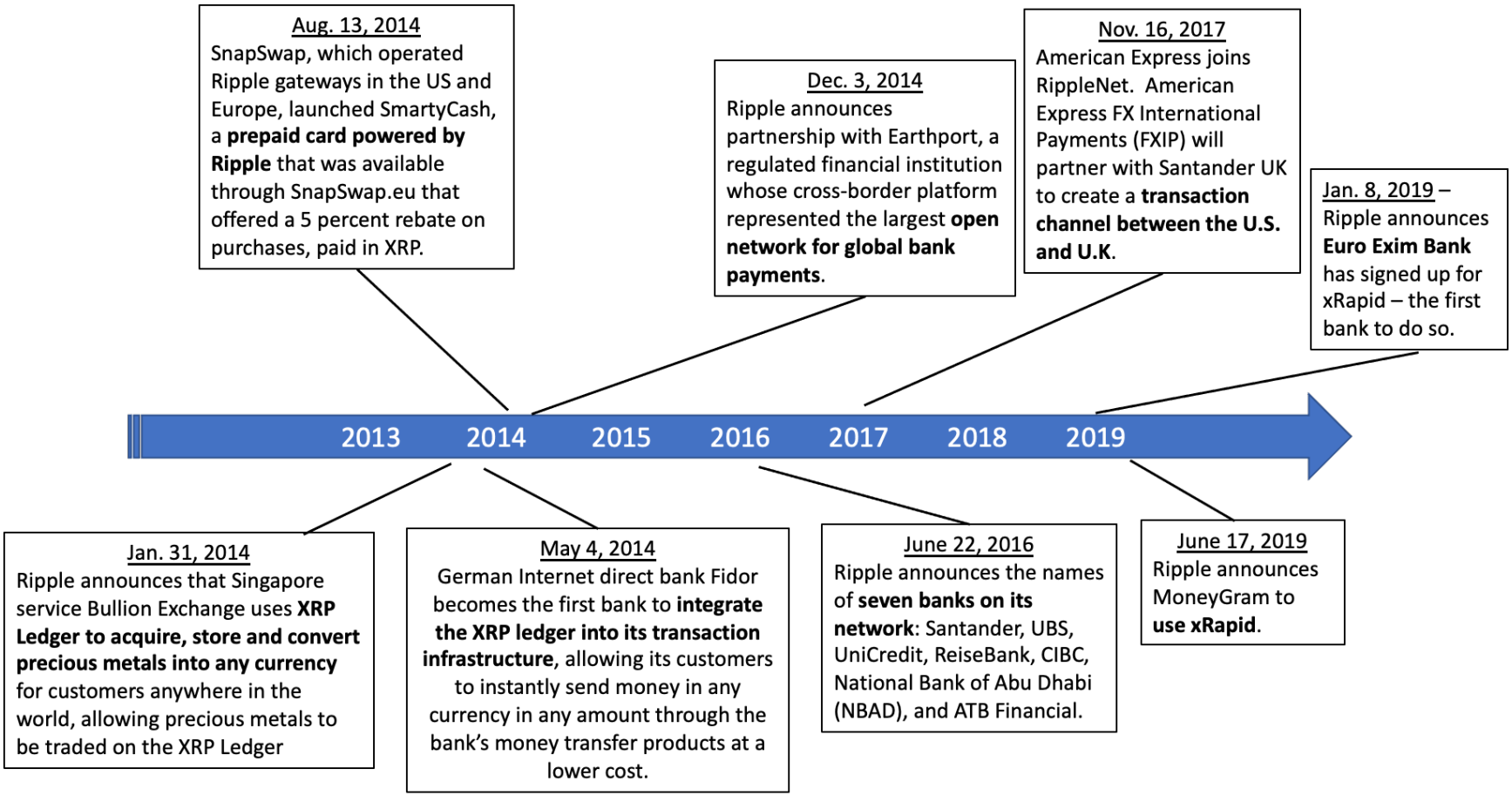

Chart 7. Timeline history of product adoption (use case examples) by market participants

115. By 2013, the XRP Ledger already had 12 gateways (payment systems), or on-ramps and off-ramps to the XRP Ledger that allowed funds to enter and exit the Ledger using fiat currencies. Building on its original vision of creating a payments network, Ripple then experimented with the best ways to build use cases leveraging the XRP Ledger and XRP. For example, Ripple entered into a partnership with ZipZap and SnapSwap to build a means for people to complete online transactions by paying in cash at selected locations, rather than by requiring bank accounts to buy and sell XRP.[84] In 2014, the partnership with SnapSwap resulted in the launch of a pilot program debit card, SmartyCash, that offered a 5 percent rebate on purchases, paid in XRP.[85] This early product pilot validated the value proposition of disintermediation of payments, and Ripple as a digital payments company.

116. By 2014, a new use case (service) was launched by Bullion Exchange, a Singaporean entity, in which gateways to the XRP Ledger could be used to convert gold and precious metals into any currency.[86] Users maintained a balance in an XRP Ledger wallet (similar to a bitcoin wallet), while the bullion itself was vaulted in Singapore. Users were then able to use that balance to pay anyone instantly in any currency available on the XRP Ledger, or trade the bullion itself. The use case demonstrated that the XRP Ledger was not only useful for digital payments, but also could be used to support digital transactions of physical goods.

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[84] Danny Bradbury, *Ripple Labs Now Taking Cash Payments Following Deal with ZipZap and SnapSwap* (Oct. 8, 2013), CoinDesk, https://www.coindesk.com/markets/2013/10/08/ripple-labs-now-taking-cash-payments-following-deal-with-zipzap-and-snapswap/.

[85] A Debit Card Powered by Ripple (Aug. 13, 2014), Ripple, https://ripple.com/insights/a-debit-card-powered-by-ripple/.

[86] Jon Southurst, *Bullion Exchange Brings Ripple into the Physical World* (Jan. 31, 2014), CoinDesk, https://www.coindesk.com/markets/2014/01/31/bullion-exchange-brings-ripple-into-the-physical-world/.

117. Starting in 2015, Ripple started announcing partnerships with global banks to facilitate currency exchange and cross-border settlements, around the time of its A round investment.[87] The involvement of banks as investors in Ripple sends a signal that Ripple was seen as an important solutions provider in the global payments market and that fintech had become a scalable disruptive innovation as early as 2015. The announcement of two licensed products for banks, cross-currency settlement and foreign exchange market making,[88] as well as a partnership with Earthport, a regulated financial institution with a platform representing the largest open network for global bank payments, represented major entries in the global settlements space.[89] Many additional banking transaction channels and Ripple partnerships with global banks and major financial corporations followed in 2016 and continue until today as trust in fintech integration in banking transactions has developed and software solutions have become more broadly accepted.

118. Importantly, it is not necessary for the development of Ripple's business that all, or even any, of these specific applications have proved commercially successful. Again, as I explained above, it is routine for high-technology businesses seeking to capitalize on novel technology to proceed through numerous iterations of their products as they seek the appropriate market niche. Ripple's development is fully consistent with that pattern.

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[87] Monica Long, *Ripple Adds Santander InnoVentures Fund as Series A Investor* (Oct. 6, 2015), https://ripple.com/ripple_press/ripple-adds-santander-innoventures-fund-as-series-a-investor/.

[88] Monica Long, *New Ripple Settlement and FX Solutions Lower the Total Cost of Settlement for Banks and Their Customers* (Oct. 6, 2015), Ripple, https://ripple.com/ripple_press/new-ripple-settlement-and-fx-solutions-lower-the-total-cost-of-settlement-for-banks-and-their-customers/.

[89] *Ripple Labs and EarthPort Announce Global Partnership* (Dec. 3, 2014), Ripple, https://ripple.com/insights/ripple-labs-earthport-announce-global-partnership/.

IV. The Ecosystem of the XRP Ledger and XRP Is Decentralized, and Has Many Different Uses and Potential Uses

119. Ripple has built and catalyzed a wide range of use cases leveraging open-source distributed ledger technology for payments without a trusted third party. While cross-border payments and bank settlements are a target market for Ripple, the vision was to enable a broader internet of value. This internet of value does not only pertain to the movement of money, but to enable the exchange of any asset that is of value to someone, including stocks, votes, frequent flyer points, securities, intellectual property, music, scientific discoveries, and more. Some use cases are developed or enabled directly by Ripple; others result from third-party developers.

A. Products Developed by Ripple

120. During its product development, Ripple has enabled several important use cases related to payment services, cross-currency settlements, and FX (foreign exchange) solutions.[90] While not exhaustive, some key use cases are shown in Charts 6 and 7, predominantly focused on institutional users such as banks and financial institutions. Ripple's products in service of its global-settlements use cases include:[91]

- RippleNet is a payment platform, powered by the XRP Ledger, that is Ripple's flagship product suite for financial institutions. The purpose of RippleNet is to facilitate cross-border payments. It can leverage blockchain technology to process transaction information in mere seconds and, through its On-Demand Liquidity (ODL) feature, allows customers to send value across certain fiat currency pairs in a matter of minutes using XRP as a bridge currency.
- RippleNet comprises three main products formerly referred to as xCurrent, xVia, and xRapid.

[90] Monica Long, *New Ripple Settlement and FX Solutions Lower the Total Cost of Settlement for Banks and Their Customers* (Oct. 6, 2015), https://ripple.com/ripple_press/new-ripple-settlement-and-fx-solutions-lower-the-total-cost-of-settlement-for-banks-and-their-customers/.

[91] Pedro Febrero, *A Guide to the Ripple Product Suite* (Feb. 21, 2019), Coin Rivet, https://coinrivet.com/guides/altcoins/a-guide-to-the-ripple-product-suite/.

- xCurrent is a global real-time gross settlement system that enables participants to message, clear, and settle transactions. Gross settlement means that transactions are handled and settled individually, rather than bundled together. If two banks have made nostro/vostro (one bank keeps money at another bank) arrangements, xCurrent can change balances on both ends in seconds. Since xCurrent is built on top of the Interledger Protocol (or "ILP," described in more detail below), users can exchange foreign currency rates in real time, and it is not dependent on XRP.
- xVia is a software solution used by businesses to plug into RippleNet to send payments.
- ODL, formerly known as xRapid, is a liquidity solution for banks that uses XRP as a bridge currency to eliminate delays in global payments while also lowering their cost, thus making cross-border payments instant and inexpensive. It eliminates the need for foreign-currency accounts. A financial institution can also use RippleNet without its on-demand liquidity feature. In that case, the main advantages are settlement speed, accuracy, and end-to-end traceability.

- Ripple products also make use of ILP,[92] an open protocol suite for sending payments across different ledgers, most often cited by third-party developers as a key differentiator for adopting XRP or use of the XRP Ledger. Much like the internet, connectors route packets of money across independent networks. The open architecture and minimal protocol enable interoperability for any value transfer system.[93] Traditional payment networks operate independently from each other. Sending value is easy only if the sender and recipient have accounts on the same network, but it can be slow and expensive if they have accounts on different networks. Interledger makes it easy to transact in whatever currency or payment network you choose, because it is not tied to any one company, blockchain, or currency. Using ILP, XRP can be sent to someone who wants to receive

[92] Dalmas Ngetich, *Ripple's Interledger Protocol (ILP) is what the internet of value needs to thrive* (Apr. 5, 2019), EthereumWorldNews, https://ethereumworldnews.com/ripples-interledger-protocol-ilp-is-what-the-internet-of-value-needs-to-thrive/.

[93] Interledger Foundation, *The Interledger Protocol*, https://interledger.org/developer-tools/get-started/overview/.

ether, or you can send U.S. Dollars to someone who wants to receive Euros. In June 2017, Ripple open-sourced the first bitcoin plugin for ILP, which would help users carry out transactions across multiple ledgers, not just the XRP Ledger, but also including private blockchains, public networks, a traditional payment channel, and a centralized ledger.

121. Ripple is a leading fintech company in an increasingly scalable and robust cryptocurrency ecosystem. Accolades from leading media such as FastCompany[94], Forbes FinTech 50,[95] CBInsights FinTech 250,[96],the World Economic Forum,[97] and American Banker[98] have recognized the commercial value of the company in its product development and market growth path. Further, the Consumer Financial Protection Bureau (CFPB) recognized the promise of Ripple's technology to provide transparency to consumers regarding cost of cross border remittances.[99] In addition, the International Monetary Fund (IMF) indicated that "new non-bank

[94] Morgan Clendaniel, *World Changing Ideas 2019: All the winners, finalists, and honorable mentions* (Apr. 8, 2019), Fast Company, https://www.fastcompany.com/90329244/world-changing-ideas-2019-all-the-winners-finalists-and-honorable-mentions.

[95] Michael del Castillo, *Blockchain 50: Billion Dollar Babies* (Apr. 16, 2019), Forbes, https://www.forbes.com/sites/michaeldelcastillo/2019/04/16/blockchain-50-billion-dollar-babies/?sh=4647f85a57cc.

[96] BusinessWire, *CB Insights Reveals the Fintech 250 List at Future of Fintech* (June 19, 2017), Bloomberg, https://www.bloomberg.com/press-releases/2017-06-29/cb-insights-reveals-the-fintech-250-list-at-future-of-fintech.

[97] *Ripple Labs Awarded as Technology Pioneer by World Economic Forum* (Aug. 5, 2015), Ripple, https://ripple.com/ripple_press/ripple-labs-awarded-as-technology-pioneer-by-world-economic-forum/.

[98] *20 Fintech Companies to Watch* (Oct. 12, 2015), American Banker, https://www.americanbanker.com/slideshow/20-fintech-companies-to-watch.

[99] Remittance Transfers under the Electronic Fund Transfer Act (Regulation E), 85 Fed. Reg. 34870, 34880 (June 5, 2020), https://www.govinfo.gov/content/pkg/FR-2020-06-05/pdf/2020-10278.pdf.

players [such as Ripple] are entering the payments space offering innovative services to regulated financial institutions and to consumers and merchants."[100]

B. Products Enabled by Ripple

122. The XRP Ledger and XRP are used in software products beyond those developed and commercially offered by Ripple. In that regard, Ripple's developer tools and their partnerships, investments, and acquisitions have led to important use cases that increase the liquidity of XRP and technical innovations in the use of XRP and the XRP Ledger, thus benefitting Ripple's own products:

- RippleX hosts an open payment developer platform[101] that provides infrastructure, tools, services, programs, and support for creation of new applications on the XRP Ledger. An open community of developers, including those associated with UBRI, can advance solutions and innovations needed to allow businesses, consumers, institutions, and governments to grow applications in the digital economy. RippleX is built on the principle that the success of blockchain in realizing the Internet of Value hinges on how easily new technology integrates with or displaces incumbent solutions. For example, the platform offers a software development kit (SDK) that allows crypto and non-crypto developers to integrate payments into any mobile application.
- RippleX also builds infrastructure and helps innovative blockchain projects grow through investments in emerging companies, acquisitions, and new partnerships. For example, RippleX partners with a major global blockchain payments provider (BitPay), a cryptocurrency wallet (BRD Wallet), a blockchain analysis company (Chainalysis), and a digital asset custody platform (Anchorage) to enable the development of new products and services. Further, several examples of RippleX's investments and acquisitions include:

[100] International Monetary Fund, *Technical Note on Supervision of Financial Market Infrastructures, Resilience of Central Counterparties and Innovative Technologies*, United States: Financial Sector Assessment Program, Country Report No. 20/249 (Aug. 2020).

[101] *RippleX Open Developer Global Payment Platform*, Ripple, https://ripple.com/ripplex/.

- The acquisition (really an acqui-hire) of crypto-trading company ***Algrim*** focused on developing foreign exchange algorithms.
- The acquisition of ***Logos***, a turnkey payments solution focused on scale and sustainability, has been integrated in the development of a decentralized finance (DeFi) system built on the XRP Ledger. The focus on DeFi will allow the XRP Ledger to compete with Ethereum in this space.
- The acquisition of ***Strata***,[102] focused on developing and operating node infrastructure and services for the ILP network has enabled some of the first truly internet-native micropayments, with more than 10 billion transactions flowing on the ILP network for applications such as Coil[103] and Stronghold.[104] Coil is a content monetization platform that allows creators, developers, companies, and nonprofits to receive compensation in XRP for their content. Stronghold is a company that creates virtual payment networks to enable instant settlement and interoperability between legacy and new payment networks. The proprietary code from Strata's infrastructure will be opened to allow all developers to use it for their own projects and make the ILP network more accessible.

C. Other Products and Use Cases

123. Further, a plethora of new products/services and use cases leveraging the XRP Ledger or XRP have been developed by other individuals and companies. Aside from multiple e-commerce companies using the XRP Ledger because of its speed and cost benefits, payment processors, micropayment platforms, and non-profits have built application use cases that demonstrate the breadth and depth of the commercial value of the XRP Ledger and XRP.

[102] *Welcoming Strata Labs*, Coil, https://coil.com/p/xpring/Welcoming-Strata-Labs/cArrz5jdt.
[103] *See Coil – A New Way to Enjoy Content*, https://coil.com/.
[104] *See* Stronghold, *Providing Financial Services For All*, https://stronghold.co/.

124. To assess the value and impact of these use cases, and to identify a subset useful for illustrative purposes, I evaluated an initial list of 660 use cases for XRP or the XRP Ledger, supplied by counsel and attached as Appendix C, against three criteria:

- First, I cross-referenced this list against Crunchbase[105] to assess whether these companies had received equity investment, as of June 2021. This step indicates whether the use cases were perceived by the investment community as growth companies with the capacity to scale. I rely on Crunchbase because it is a leading firm that, in my experience as an expert in this space, is a reliable source of information regarding whether particularly innovative firms received equity funding.
- Second, I determined, using the same databases, the founding date of the companies behind those use cases. This step identifies and eliminates companies that could not have been started as the result of adopting the XRP Ledger or XRP. However, some companies founded prior to this cutoff date may have implemented some use case for XRP or the XRP Ledger. Thus, the actual population of companies using XRP and the XRP Ledger could be much larger than the population examined.
- Third, I examined the applications for the remaining use cases. The purpose of this step was to understand which innovations are being powered by the XRP Ledger or which support the cryptocurrency XRP for payments or other commercial uses.

[105] Crunchbase, https://www.crunchbase.com.

125. Out of the 660 use cases initially identified, 153 companies were founded after Ripple's incorporation (2012). Of those 153, I identified 91 use cases with equity investment data.[106] Chart 8 reports on those data:

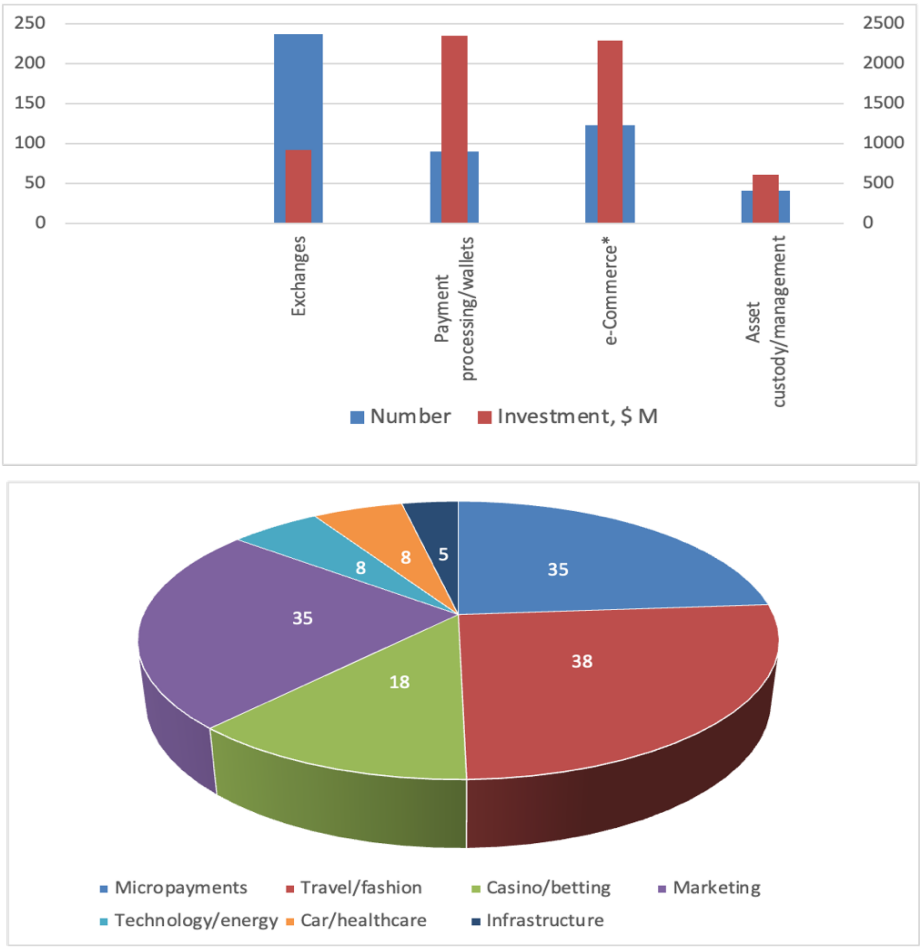

Chart 8. Distribution of use cases leveraging XRP or XRPL technology

126. Several features of Chart 8 merit explication. First, this chart indicates that venture capital invested over $6 billion in these 91 companies. Most of the financing was for payment processing/digital wallets and e-commerce companies (indicated by the number of companies). E-commerce use cases, in turn, were dominated by micropayments, marketing, and

[106] *See* Appendix D.

travel/fashion companies seeking to use XRP as a means to monetize data or to transact contractual agreements and payments. This data is updated as of June 2021.[107]

127. I have also identified particular use cases that I believe represent a spectrum of applications leveraging either XRP and the XRP Ledger, and which provide information on the value proposition of these technologies.

128. **Stablecoins.** The Estonian company CoinField introduced "Sologenic" – built on the XRP Ledger to issue stock and fiat-backed stablecoins.[108] "SOLO" coins are issued on the XRP Ledger, allowing liquidity to be moved in a matter of seconds. This creates a dynamic bridge between crypto assets and non-blockchain-based assets by being paired directly with fiat currency as collateral to settle with third-party brokerage firms. SOLO is available for trading on CoinField's existing exchange, CoinField's upcoming DEX, and major global crypto exchanges. According to CoinMarketCap,[109] the live market cap of Sologenic is $167,033,890 USD. It has a circulating supply of 200,001,808 SOLO coins and a maximum supply of 400,000,000 SOLO coins, which trade at $0.85.

129. **Micropayments.** Coil is a platform that provides an alternative method for gaming, video, and blog creators to monetize their content online.[110] As subscribing fans consume content, the platform uses an open API called Web Monetization to stream micropayments to creators instantaneously. The Coil application is built on the Interledger Protocol, and it supports

[107] Because this information is necessarily dynamic, I reserve the right to update my analysis if necessary before trial.

[108] *CoinField Introduces "SOLOGENIC" - built on XRP ledger to issue stock and fiat backed stablecoins* (Oct. 15, 2019), Coinfield, https://www.globenewswire.com/en/news-release/2019/10/15/1929657/0/en/CoinField-introduces-SOLOGENIC-built-on-XRP-ledger-to-issue-stock-and-fiat-backed-stablecoins.html.

[109] *Sologenic*, CoinMarketCap, https://coinmarketcap.com/currencies/sologenic/.

[110] Cory Johnson, *Full Court WordPress: Coil Deal Boosts Functional Blockchain — And XRP* (May 19, 2020), Forbes, https://www.forbes.com/sites/coryjohnson/2020/05/19/full-court-wordpress-coil-deal-boosts-functional-blockchain---and-xrp/?sh=96f0ba8283ed.

XRP payments in real time thanks to a partnership with the XRP Ledger wallet provider GateHub.[111] A recent seed investment of Coil in Cinnamon, a video streaming app, will allow for XRP micropayments to reward content creators on YouTube.[112] Similarly, Audiotarky uses Coil's web monetization micropayment platform – built on the Interledger Protocol to pay musicians for content by using XRP.[113] RippleX (then Xpring) participated in Coil's $4 million seed round and provided a 1 billion XRP grant to the platform, worth roughly $265 million at the time.[114] The Coil application has 300 million users, a market capitalization of nearly $1M, and a coin circulation of 1,014,094.00 COIL, which trade at $0.95.[115]

130. **Travel.** TapJets is a private jet chartering service that accepts multiple cryptocurrencies, including (until recently) XRP, to settle transactions. It offers instant on-demand private jet booking for private jet charters in the U.S. and worldwide by focusing on the entire user experience of private travel. TapJets offers a Rewards Program and a dedicated 24x7 concierge staff for each trip. TapJets decided to accept XRP for payments after conducting a poll of its customer base on Twitter.[116]

131. **Video Gaming.** Forte is a video game development company enabled by blockchain with a strong focus on gaming.[117] The company is leveraging the open-source ILP to seamlessly

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[111] Marie Huillet, *Ripple-Backed Web Monetization Platform Coil Now Supports XRP* (Oct. 2, 2019), CoinTelegraph, https://cointelegraph.com/news/ripple-backed-web-monetization-platform-coil-now-supports-xrp.

[112] Gerelyn Terzo, *Cinnamon Spices Up Video Streaming With Ripple Tech* (Feb. 22, 2019), https://cryptobriefing.com/cinnamon-spices-video-ripple-tech/.

[113] Fans Manual, AudioTarky, https://www.audiotarky.com/$/manual/fans.

[114] *Ripple's Xpring Invests $260 Million in Coil Content Platform* (Aug. 15, 2019), Ledger Insights, https://www.ledgerinsights.com/xrp-ripple-xpring-invests-260-million-coil-content/.

[115] *Coil*, CoinMarketCap, https://coinmarketcap.com/currencies/coil/.

[116] TapJets – Instant, Private, Safe and Simple (@TapJets), Twitter (May 15, 2018), https://mobile.twitter.com/tapjets/status/996402253195079682.

[117] Darryn Pollock, *Ripple Partner Forte Teaming Up With Game Developers to Integrate Blockchain* (Mar. 24, 2020), https://www.forbes.com/sites/darrynpollock/2020/03/24/ripple-partner-forte-teaming-up-with-game-developers-to-integrate-blockchain/?sh=201614da1435.

facilitate cross-blockchain transactions in its platform, and using the ILP to connect the XRP Ledger with other ledgers.[118] This directly benefits game developers by allowing them to focus on creating great experiences instead of worrying about a particular technology or the need to become an expert in blockchain. The company has recently partnered with a host of well-regarded game developers to try and implement blockchain and unlock never-before-possible revenue streams in traditional game designs, while being versatile enough to serve as the economic and creative foundation for blockchain-native experiences. Its gaming partners include Hi-Rez Studios, Netmarble, Magmic, nWay, and DECA Games, as well as Disruptor Beam, Other Ocean, and Kongregate. XRP will serve as the settlement currency, following a backing by Ripple with a $100M fund.[119]

132. **Data Privacy.** Data443 is global data privacy management company focused on the distribution, protection, and stewardship of data that runs five validators on the XRP Ledger.[120] Data443 data classification, e-discovery, and European Union's Global Data Protection Regulation ("GDPR") compliance tools are integrated with the XRP Ledger.[121] The GDPR governs data protection and privacy as well as data transfers outside of the European Union. Data443 chose to work with Ripple's technology because the XRP Ledger is enterprise-focused with a level of maturity and capability in the blockchain realm. Data443 works with some of the

[118] Danny Aranda, *Partnering with Forte* (Mar. 12, 2019), Xpring, https://medium.com/xpring/partnering-with-forte-44b6d3304bbb.

[119] *Ripple-Backed Startup Pushing to Bring XRP to $140 Billion Gaming Industry Announces Slew of Partnerships* (Nov. 23, 2020), The Daily Hodl, https://dailyhodl.com/2020/11/23/ripple-backed-startup-pushing-to-bring-xrp-to-140-billion-gaming-industry-announces-slew-of-partnerships/.

[120] *DATA443 (OTCPK:LDSR) Contributes to Ripple* (Feb. 1, 2018), Intrado GlobeNeswire, https://www.globenewswire.com/news-release/2018/02/01/1330179/0/en/DATA443-OTCPK-LDSR-Contributes-to-Ripple.html.

[121] *Data443 Classification, eDiscovery and GDPR Compliance Now Available for Use with Ripple Blockchain* (May 24, 2018), GlobeNewsWire, https://data443.com/data443-classification-ediscovery-and-gdpr-compliance-now-available-for-use-with-ripple-blockchain/.

world's largest data and cybersecurity companies to develop and market its services, including Microsoft, Citrix, and CyberArk.[122]

133. **Payment Processing.** NOWPayments is a crypto payment gateway that lets businesses accept XRP payments and donations for consumer goods and services. The company chooses to deploy payment processing on the XRP Ledger because transactions are characterized by extraordinary speed and near-zero fees, as well as a high level of security.[123] Cryptocurrencies including XRP, Bitcoin, and ether allow for payments for a wide range of applications, including payroll[124] to send salaries or bonuses in crypto, or for any business dealing with payouts on a regular basis. The company has restaurants, freelance, and commission-based companies in its client base.

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134. The development of these use cases – those built by Ripple, those invested or enabled by Ripple, and those developed by third parties – undermines any suggestion that the XRP Ledger or XRP lack inherent commercial utility. Rather, the XRP Ledger is an innovative technology, which facilitated XRP becoming one of a top tier of the largest cryptocurrencies. Both of these technologies have found uses in a wide variety of use cases. Although the primary application for Ripple's products was aimed at payments, these derivative applications are in payment services, micropayments, data security, and other uses that are not related to institutional settlements. In many cases, new businesses leverage XRP and the XRP Ledger to build scalable services in the digital economy that form the basis of new value transfer applications in

[122] *Associations & Partners*, Data443, https://data443.com/our_partners/.

[123] *Accept XRP Payments*, NowPayments, https://nowpayments.io/supported-coins/xrp-payments.

[124] *NOWPayments introduces cryptocurrency salary payments solution for employers* (Mar. 16, 2021), https://thepaypers.com/cryptocurrencies/nowpayments-introduces-cryptocurrency-salary-payments-solution-for-employers--1247802?utm_source=dlvr.it&utm_medium=twitter.

industries well beyond Ripple's primary use case for XRP as a bridge currency for cross-border settlements.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct. Executed on October 4, 2021

Peter Adriaens

Appendix A - Curriculum Vitae

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https://www.researchgate.net/profile/Peter_Adriaens2
https://www.difin.io

CURRICULUM VITAE FOR PETER ADRIAENS, PhD, PE, BCEEM, NAE[1]

Director, Center for Smart Infrastructure Finance, The University of Michigan
Professor (tenured), Department of Civil and Environmental Engineering, The University of Michigan
Professor of Entrepreneurship (without tenure), Ross School of Business, The University of Michigan (20006-16)
Professor (without tenure), School for Natural Resources and the Environment, The University of Michigan
Finnish Distinguished Professor, Research Institute of the Finnish Economy, Helsinki, Finland (2013-16)
Distinguished Prof. of Entrepreneurship, Sichuan Univ., Suzhou Higher Education Innovation Park, China (2006-16)

Education:
Postdoctoral Scholar: Environmental Engineering Science - Stanford University (1990-1992)
Ph.D.: Environmental Sciences, Univ. of Calif., Riverside (1989)
M.S.: Environmental Biotechnology and Bioengineering, Univ. of Gent, Belgium (1986)
B.S.: Agricultural Engineering, Univ. of Gent, Belgium (1984)

Academic and Professional Positions:
Professor, Civil and Environmental Engineering (since 1992), The University of Michigan; Professor of Entrepreneurship and Strategy, Ross School of Business (since 2006); Finnish Distinguished Professor, Helsinki, Finland (2014-2016); Chair, Foundation of the Association of Environmental Engineering and Science Professors (2017-2020); Vice-President, President-Elect and President, Association of Environmental Engineering and Science Professors (AEESP; 2007-2009); Distinguished Professor of Entrepreneurship, Sichuan University, China (current).

Nonacademic Positions
CTO and co-founder, Equarius Risk Analytics (2013 - current); Co-Founder, Corymbus Asset Management (2016 – 2017); President, Global CleanTech LLC (2007 - current); CEO, KeyStone Compact Group Ltd, (2009-2014) and KeyStone Compact UK, Ltd (2014-2016); Co-Founder, Global CleanTech Cluster Association, a Swiss foundation (2010 – 2017); Academic-in-Residence and Director for Asian Operations, LimnoTech (2006-2013).

Research Interests:
Environmental Engineering (1991-2006): Technology development for natural and engineered microbial systems; Risk and uncertainty management for site characterization and technology implementation; Microbial sensing in complex environmental systems; Green infrastructure design
Entrepreneurship and Digital Finance (2006-current): Financial network theory models; Smart infrastructure finance; Blockchain finance.

Teaching Experience:
Environmental Engineering: Environmental Bioengineering (1992-2002); Civil and Environmental Engineering Capstone Design Course (2004-2006); Case Studies in Sustainability (2009-2011)
Entrepreneurship and Finance: Entrepreneurial Business Fundamentals (2006-current); CleanTech Entrepreneurship (2007-current); CleanTech Venture Assessment (2007-2014); Introduction to Business Models (2009-2011); Environmental Finance (2015-current); Water Risk in the Capital Markets (2016-2019); Infrastructure Project Finance (2019-current); Engineering Economics and Finance (2020-current).

Project Management Experience:
PI, Nuveen-UM municipal bond program; Program PI, Digital Financing of Agriculture; Program PI, Design and validation of Multi-Asset Renewal Funds to for transitioning to low-carbon economies (Finland; 2013-2016); Great Lakes and St. Lawrence Blue Growth Fund Advisory Board (2016 - current); Low Carbon Technology Team Expert, Asia Development Bank (2013-2016); Project Director or Co-PI for in excess of $22M in national and international research grants since 1994, involving multiple institutions; Responsibility for financial and technical reporting; Interviewing, hiring and releasing of project staff

[1] *Royal Flemish Academy of Applied Science and the Arts*

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https://www.researchgate.net/profile/Peter_Adriaens2
https://www.difin.io

members, students and postdocs; Facilities design and remodeling for project-specific requirements; Laboratory quality, data management, and financial compliance with external audits (EPA, NSF, NIH).

Administrative Experience:
Director, Center for Smart Infrastructure Finance and co-director UM-FinTech Collaboratory, University of Michigan; Program Director, Master of Engineering in Smart Infrastructure Finance, Civil and Environmental Engineering, The University of Michigan; International project management (GCCA, Research Institute of Finnish Economy); Member and co-chair, Chair, Scholastic Standing Committee (2017-2019); Alumni Development Committee, CEE (2012-2016); Member, Search Committee, Executive Director Zell Lurie Institute for Entrepreneurial Studies (2012-2013); Chair, COE Nomination Committee (2008-2011); President/President-Elect/Vice President, Association of Environmental Engineering and Science Professors (2007-2010); Chair, COE Nomination Committee (2008-2011); Member, Innovation Committee, Pfizer Facility Expansion (2009-10); Chair, Internal Assessment Committee, Taubman School of Architecture and Urban Planning; Founding Member, Center for Entrepreneurship, College of Engineering, The University of Michigan; Member, Faculty Senate Assembly, University of Michigan (2006-08); Member, Dean Search Advisory Committee, College of Engineering (2005-06); Program Director, Environmental Technology Council, College of Engineering (2001-2006); Environmental Faculty Steering Committee, 2001-2004; Acting Director, EPA/DOD National Center for Integrated Bioremediation Research and Development (NCIBRD), Oscoda, Michigan, 7/31/02-8/31/03; Associate Director, Institute for Environmental Science, Engineering and Technology (IESET), 09/01/00-8/31/02; Co-Director, Initiative in Sustainable Aqueous Systems (iSAS), 2001-2004; Member, CEE Executive Committee, 2002-2004; Chair, College of Engineering Honors and Awards Committee (01-02); Member, *ad hoc* Committee for Infrastructure Initiative (2001); COE Awards Committee Member, 09/00-8/01; Department Executive Committee, 1998-01 and 02-03; Chair, Promotion Committees PRS Dr. Jiasong Fang and Dr. Andrei Barkovskii; Curriculum Committee, Dept. Civil & Environ. Eng., 1994-1995, 1996-97; Research Committee, Dept. Civil & Environ. Eng., 1995-1996; Departmental Awards Committee, 1996-98; Grant Management/Budgeting, 1992-present.

National and International Service (last 20 years):
National Science Foundation site review committee, ReNUWit (Reinventing Urban Water Infrastructure) ERC Center (Stanford-Berkeley-Colorado School of Mines) 2013-2017; Member, AEESP Foundation (2010-2013); Co-Chair (with Gregory Characklis, University of North Carolina, Chapel Hill), NSF Workshop on “Integrating Economic and Financial Principles into Environmental Engineering Research and Education”, Washington DC (January 26-28, 2011); President, Association of Environmental Engineering and Science Professors (AEESP), 2009-2010; President-Elect, AEESP, 2008-2009; Vice President, AEESP, 2007-2008; International Advisory Board, Center for Environmental Science and Engineering – Dalian, China (Since 2006); Member, NSF CLEANER Program sensor development committee (2005-2007); Chair – Membership Committee, Association of Environmental Engineering and Science Professors (AEESP); International Advisory Board, Program on Sustainable Land Use, German National Environmental Laboratory, Leipzig, Germany (2003-2008); Member, Sustainable Water Resources Management Group, Mexico City (Director: Prof. Vaca Mier, Autonomous University of Mexico), since 2000; External Appraisal Team, Ontario Council on Graduate Studies, Department of Chemical Engineering and Applied Chemistry, University of Toronto, May 13-15, 2002; Principal Editor, Bioavailability and Bioremediation Domain, TheScientificWorld, Inc., 2001-2004; Member, Review committee, Swedish Environmental Research Foundation – Cold Climate Bioremediation Research Program, 11/01, Stockholm, Sweden; Founding Member, Environmental Science and Technology Magazine Advisory Board, 2001-2004; International Advisory Board and Scientific Committee, International Symposium for Environmental Biotechnology (ISEB 2002), Veracruz City (Mexico); International Advisory Board, Biosorption and Bioremediation Conferences, Prague, Czech Republic (since 2000); Associate Editor, J. Contaminant Hydrology (1999-2003); Science Advisory Committee, South & Southwest Hazardous Substance Research Center (1998-2002).

Innovation and Commercialization Activities (since 2000):
CEO, KeyStone Compact Group, Ltd dba Corymbus Asset Management (Ann Arbor – London, UK – Singapore – Zurich, Switzerland); CEO, Equarius Risk Analytics, LLC, Ann Arbor, MI; Co-Founder and

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Global Head Judge, Global CleanTech Cluster Association (since 2010); Panel moderator, Global CleanTech Investment, Cleantech Venture Day, Lahti, Finland (4/12); Invited Speaker, Low Carbon Investment Conference, London, UK (11/11); Co-Organizer and Panel Moderator, Enterprise Ireland CleanTech Investment Conference, Dublin, Ireland (11/11); Invited Speaker, Asia-Pacific Business Leaders Sustainability Conference, Sentosa Island, Singapore (10/11); Panel Moderator and Speaker, Asia-Pacific CleanTech Investment Forum, Singapore (7/11); Conference Co-Chair, Global CleanTech Cluster Association EcoCities Investment Conference, Montreal, QC, Canada (2011); Head Judge, Global CleanTech Cluster Association (http://www.globalcleantech.org/, since 2011); Advisory Board, OnGreen (http://www.ongreen.com/, since 2010); CleanTech Advisor, Frankel Commercialization Fund and Wolverine Venture Fund (since 2007); Co-Advisor (with Tom Lyon, Dow Professor of Sustainable Science, Technology and Commerce and Director, Erb Institute of Global Sustainable Enterprise), The Ben Franklin Project: Structuring Agreements for Chinese Investment in US CleanTech Startups (2010-2011); Project Director: Water Footprints and Business Water Risk: Investment in Risk Management Strategies (2011-2012); Member, World Resources Institute, Aqueduct Alliance for Business Water Risk (2010-2013); Conference Chair, Michigan-China Clean Tech: Collaboration and Competition in Energy, Smart Grid, Green Cities and Transportation, Ann Arbor MI (2010); Panelist, West Coast CleanTech Forum, Vancouver, BC, Canada (2010); Keynote Speaker (closing session), Societal value Creation from Biotechnology, International Symposium for Environmental Biotechnology, Italy (2010); Co-Chair, Cleantech Investment and Policy Conference, Ann Arbor MI (2009); Technical Advisor, CTSI Clean Technology and Sustainable Industries Conference and Trade Show (2008-2010); Chair, CleanTech Venture Opportunities Conference, Ann Arbor MI (2007); Chair, Emerging CleanTech Opportunities workshop, CleanTech Venture Conference, Toronto, ON, Canada (2007); Consultant to Africa Stockpiles Program (World Bank), Geneva, Switzerland (11/06-1/08); Roundtable on Entrepreneurship Education (participant), Stanford University, CA (10/06); Sustainable Water Resources Round Table (Department of Interior) Workshop on Multi-Stakeholder Use of the Great Lakes (Co-chair with Paul Freedman, Limno-Tech, and Robert Goldstein, Electric Power Research Institute), Ann Arbor, MI (April, 2005); SERDP/ESTCP Workgroup on Sediment Remediation Strategies, Charlottesville, VA (8/04); Technology Benchmarking Workshop for Remediation of Dioxin-Contaminated Sediments and Floodplains, Ann Arbor, MI (3/04); Technology transfer – Bioremediation in Cold Climates, Lund, Sweden (plenary lecturer); Remediation Technologies Development Forum (Sediments group), Seattle, WA; 11/02; 220 participants, Plenary lecturer; University of Michigan Great Lakes Symposium: Our Challenging Future (hosted by Michigan Sea Grant, the School for Natural Resources and the Environment, and the Center for Sustainable Systems), Ann Arbor, MI; 11/02; 150 participants, session leader and key-note speaker (Sediment Contamination, Toxicity, and Beneficial Re-Use); International Roundtable – Intelligent Infrastructure for Sustainable Potable Water, International Symposium for Environmental Biotechnology, Cleaner Bioprocesses, and Sustainable Development, Veracruz, Mexico; 6/02; Organizer, International Advisory Committee, and Plenary lecturer; Department of Environmental Quality-Emergency Response Division, Innovative Technology Seminar, East Lansing, MI; 5/02; 120 participants; key-note speaker; Technology Transfer for Contaminated Sediments, The Housatonic Valley Association and Housatonic River work group, Utica, New York, 2/02. Lecturer; Michigan Environmental Health Association Ground Water Conference, Thompsonville, MI; 10/01; 300 participants; key-note speaker; The CWC Group, Investing in the Future of the Global Water Industry, Financing Mechanisms and Technological Needs of the Water Company of the Future, London, UK; 11/27-28 2000; 90 participants, panel member; Mexico Autonomous University, 2nd Symposium Workshop and Short Course on Sustainable Water: Issues and Technologies, Mexico City, Mexico, 11/8-11/11, 2000; Key-note speaker and lecturer; World Association of Industrial and Technological Research Organizations, Knowledge Transfer in RTOs, The Hague, The Netherlands; 10/11-10/13, 2000; Participant; Michigan Department of Environmental Quality (M-DEQ), Celebration 2000 DEQ Workshop, Roscommon, MI; 07/00; Key-Note Speaker, National Workshop on Natural Attenuation, University of Tuebingen, Stuttgart, Germany; 01/00.

Invention Disclosures/Patents

Adriaens, U.S. Provisional Application; Application No.: 62/656,627 Title: waterBeta: Evaluating Asset Risk In View Of Water Exposure (2017): Trademark for Corymbus, a cluster-based investment framework; Adriaens, Anand and Zielinski (2017): Mobi-Platform, an on-line repository for global mobility

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innovations; Adriaens, Tahvanainen and Haeuselmann (2016): Multi-Asset Renewal Funds (2017); Adriaens (2014): Equarius Risk Analytics™ and Equarius Risk™; Adriaens and Faley, 2011: Keystone Compact™ – a data-driven business design and positioning tool; Adriaens and Faley, 2012: Building KeyStone Companies™; KeyStone Score™; Adriaens, Freedman, Marr, 2013: waterBeta™; waterVaR™; Adriaens & LimnoTech: NanoCap – Method for Design of in Situ Reactive Sediment Caps (D); Vanella & Adriaens, 2010: DNAzyme-based Nanosensors for Mercury and Arsenic (USPTO # 7,709,619); Adriaens & Chang: Multicomponent Droplet Packaging into Single Microchannel (D); Adriaens & Chang: FlowGenomics (D); Adriaens & Limno-Tech: H2-GRID-A Novel Geotextile for Sediment Remediation (D); Adriaens & Chang: Parallel High Throughput and Ultrasensitive Single Molecular Detection Platform (D); Adriaens & Dolney: Reusable Microbial Fuel Cells (D).

Professional Societies/Organizations:
Academy of Management (since 2012: Entrepreneurship, Technology & Innovation Management, Organizations and the Natural Environment); American Academy of Environmental Engineers (since 2010); U.S. Association of Small Business and Entrepreneurship (since 2008); CleanTech Network (since 2006); American Society for Engineering Education – Entrepreneurship Division (since 2006); International Water Association (2003-2008); International Society for Environmental Biotechnology (2000-2006); Association of Environmental Engineering and Science Professors (since 2002); Remediation Technologies Development Forum (since 1995); American Geophysical Union (1998-2008); European Geophysical Society (1998-2007); Society for Environmental Toxicology and Chemistry (1998-2004); American Chemical Society (1990-1998); American Society for the Advancement of Science (since 1990); The Honor Society of Agriculture (1989-1992); American Society Microbiology (1988-2004); Registered Professional Engineer, Belgium (1986).

Languages:
Mother tongue: Dutch; Reading, Writing and Conversational Fluency in English, French and German.

Honors and Awards:
Finnish Distinguished Professor (2013-2016); Top-5% Global CleanTech Expert; Member, Belgian Royal Academy of Applied Sciences (2012); Member-by-Eminence, American Academy of Environmental Engineers (2009); Distinguished Professor of Entrepreneurship, Sichuan University (Suzhou Campus), China (2007-2012); Round Table on Entrepreneurship Education (REE), 2009, Best Paper Award on "Teaching CleanTech in Global Economies"; Hong Kong, China; Mayor of Dalian (China) Service Excellence Award for contributions to the City of Dalian (2009); COE Service Excellence Award (2009); George J. Huebner Research Excellence Award, University of Michigan (2007); Adjunct Professor, Eberhard-Karls University, Tuebingen, Germany (2001-2008); 2003 CH2MHill/AEESP and Parsons Engineering Doctoral Thesis Award (Student: Dr. Michael McCormick); American Chemical Society, 2000 Best Student Paper Award; Student: Alexa N. Rihana.; American Geophysical Union (Hydrology Section) Spring 1998 Best Student Paper (Alexa N. Rihana); American Chemical Society 1998 Best Student Paper Award (John M. Lendvay); American Chemical Society 1998 Graduate Student Award in Environmental Chemistry (Angela Lindner); Civil and Environmental Engineering Outstanding Research Award, 1997.

Staff and Student Mentoring:

Staff Supervision

Field research staff, 2004-2006.
Mr. Timothy Towey, Engineering Research Associate IV, 04-07; senior engineer, LimnoTech (Ann Arbor)
Dr. Shu Chi Chang, postdoc 2005-2006, Professor, National Cheng-Kung University, Taichung, Taiwan.
Dr. Mihaela Gavril, postdoc 2004-2007, currently eMBA, Trent University, Ontario, Canada.
Dr. Raveender Vannela, postdoc, 2004-2008, Assoc. Research Scientist, University of Arizona,Tempe AZ
Dr. Noemi Barabas, postdoc 2003-2004, currently senior engineer, LimnoTech, Inc. (Ann Arbor)
Dr. Cyndee Gruden, postdoc (01-03), currently Assistant Professor, University of Toledo
Ms. Anna Khijniak, M.D., assistant research scientist, 7/01-8/03, currently medical intern, UCSD.
Dr. Michael McCormick, postdoc (01-02), currently Assistant Professor, Hamilton College, NY
Mr. Charles 'Lee' Major ('96-02), field manager, national Center for Integrated Bioremediation Research and Development, Oscoda, MI

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https://www.researchgate.net/profile/Peter_Adriaens2
https://www.difin.io

Dr. Alexa N. Rihana, postdoc (00-02), currently Associate professor, Department of Civil and Environmental Engineering, Wayne State U.
Ms. Annemarie Lucas, admin. support staff/GSSA, 1999-2000
Dr. Karen Skubal, postdoc 1999-2000, Mayer Assistant Prof. of Urban and Environmental Studies, Case Western Reserve U.; senior research scientist, Argonne National Laboratory.
Dr. Babu Fathepure, associate research professor, 1995-1999, currently Associate Professor, Department of Microbiology and Molecular Genetics, Oklahoma State U.
Dr. Elizabeth Carraway, postdoc 1992-93, currently Associate Professor, Department of Civil and Environmental Engineering, Clemson University
Dr. Andrei Barkovskii, assistant research professor 1994-98, 4-8/01, currently Associate Professor, Department of Environmental Sciences, Georgia State University and College.
Dr. Iris Albrecht, visiting assistant prof. 1996-1997, stay-at-home mother/independent business owner
Dr. Mary Lynam, research technician 1994-1997

Master's and MBA Project Mentoring (sampling of last 10 years)

Ms. Jingyi Wang: "*Design of NanoCap Material for Sediment Remediation: Technology Integration*". Collaboration with LimnoTech and International Water Technologies (China)
Ms. Xiaoliu Zhao: "*Design of NanoCap Material for Sediment Remediation: Business Development*". Collaboration with LimnoTech and International Water Technologies (China)
Mr. Timothy Slusser: "*Design and Feasibility of an After-Market Business for Li-Batteries*". Collaboration with the Michigan Economic Development Corporation and Sandia National Laboratories.
Mr. Hao Niu; *"Scaling of Cost-Benefit Analysis for Green Roof Deployment: Application to Washington, DC*"; Co-Chair with Prof. Jiti Zhou, Dalian Institute of Technology, (Dalian, China.)
Dr. Roya Gitiafroz; *"Anaerobic Bioremediation of Benzene"*; Chair, Elizabeth Edwards, Univ. Toronto.
Mr. John Rice, Erb Student (SNRE/Ross School of Business); *"Real Options Analysis Financial Modeling for Investment in Hybrid Cooling Technology for the Power Industry*"; Co-Chair; with Michael Moore, SNRE, and Gautam Kaul, Ross School of Business).
Dr. Robert Levine, PhD student ChemE; *"Value Chain Analysis and Life Cycle Assessment of Algae Biodiesel: An Entrepreneurial Perspective"*.
Ms. Amy Oberlin, UG ChemE; "*Value Chain Analysis and Life Cycle Assessment of Algae Biodiesel: An Entrepreneurial Perspective"*.
Ms. Yi Zhang, Mathematical Finance; "*Value-at-Risk (VaR) Analytics for Stocks and Portfolios Exposed to Water Risk: Method Development*"; Collaboration with Equarius Risk Analytics LLC.
Ms. Christine Sun, Mathematical Finance; "*waterVaR Analytics for MSCI Steel, Precious Metals and Electric Utilities Companies*"; Collaboration with Equarius Risk Analytics LLC
Ms. Chenchen Ouyang, Natural Resources and Economics; *"Operational Risk Analytics for Water-Exposed Companies: Financial and Sustainability Disclosures"*; Collaboration with Equarius Risk Analytics LLC.
Ms. Ran Gao, Environmental Engineering; "*Quantifying Operational and Financial Risk in Portfolio Companies";* Collaboration with Equarius Risk Analytics LLC.
Ms. Yuan Liu, Statistics and Finance; *"Development of Exchange Traded Funds and Indices for Emerging Industry Sectors"*; Collaboration Equarius Risk Analytics and Research Institute of the Finnish Economy.
Mr. Alexandre Mercier, Environmental Engineering and Finance; "*Value Capture and Investment Grade of Public Firms Renewing in Smart Mobility and Smart Grid"*.
Ms. Weidi Sun, Environmental Engineering and Natural Resource Management; *"Value Capture and Investment Grade of Private Growth Firms in Smart Grid"*; Collaboration with KeyStone Compact Group Ltd and Research Institute for the Finnish Economy.
Ms. Nicole Bette, Biomedical Engineering: *"Value Capture and Investment Grade of Private Growth Firms in Smart Mobility"*; Collaboration with the Research Institute of the Finnish Economy.
Mr. Nic Miller, Environmental Engineering and Business: *"Development of Storyboard Video for Multi-Asset Renewal Funds"*; Collaboration with Research Institute of the Finnish Economy.
Mr. Viktor Passinsky, MBA, Ross School of Business: *"Strategic Financial Risk Management of Business Water Risk"*; Collaboration with Equarius Risk Analytics LLC.

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Mr. Edward Grubb, MBA, Ross School of Business: *"Strategic Financial Risk Management of Business Water Risk"*; Collaboration with Equarius Risk Analytics LLC.
Ms. Allison Shapiro, MBA Ross School of Business: "*Loan Covenant Structures for Corporations and Projects with Water Risk.* Collaboration with LimnoTech, Inc.
Mr. Vinayak Manchanda, MBA Ross School of Business: *"Business Value of Water Footprints: A Value Chain and Financial Risk Perspective"*. Collaboration with LimnoTech, Inc.
Ms. Rachel Smeak, MBA Ross School of Business: "*Business Risk Analytics in Water-Constrained Environments*", Collaboration with LimnoTech, Inc.
Mr. Satish Katpally, MBA Ross School of Business: "*Loan Covenant Structures for Corporations and Projects with Water Risk.* Collaboration with LimnoTech, Inc.
Mr. Cameron Smith, Ross School of Business: *"Structuring Business Development in China: The LimnoTech Inc Case"*. A Ross-LimnoTech project.
Ms. Elizabeth Uhlhorn, Ross School of Business: *"Business Water Risk Opportunity Development".* Collaboration with LimnoTech Inc.
Ryan Moya, SEAS and Ross School of Business: "*Industry clustering for the new mobility",* MCube collaboration with University of Michigan Department of Transportation and IOE.
Anthony Arnold, SEAS and CEE: "*Development and application of waterBeta, a financial framework for water risk pricing in equities*".

Doctoral (Chair-listed) students:

Dr. Erik Petrovskis (1995); Director of Sustainability, Meier Stores (Grand Rapids)
Dr. Hildegarde Selig (1997); Faculty, Baker College, Lansing, MI
Dr. Angela Lindner (1998); Professor and Associate Dean, U. Florida - Gainesville
Dr. Jack Lendvay (1999); Associate Professor and Department Chair, University of San Francisco
Dr. Karen Skubal (1999); U.S. Department of Energy (DOE) Office of Environmental Management (EM)
Dr. Q. Shiang Fu (2000); Research Associate, Stanford U. and Entrepreneur, US/China
Dr. Alexa N. Rihana (2000); Associate Professor (University of Detroit-Mercy.)
Dr. Michael McCormick (2001); Associate Professor, Hamilton College (New York)
Dr. Noemi Barabas (2002); Senior Associate, LimnoTech, Inc. (Ann Arbor)
Dr. Hirotaka Saito (2002); Associate Professor at Tokyo University of Agriculture and Technology
Dr. Shu Chi Chang (2005): Professor; Dept. Environmental Engrg; National Chung Hsing University
Dr. Ke (Betty) Li (2007; with Linda Abriola, Tufts University): Dupont, Philadelphia.
Dr. Corrie Clark (2007; with F. Brian Talbot, Business): Congressional Review Office, Washington DC.
Dr. Meng-ying Li (2008; with Anna Michalak, Stanford University): Assistant Professor, Taiwan
Dr. Hoa Trinh (2009; with Christian Lastoskie, Civil & Environ. Eng.): Environ. Defense Fund, Vietnam
Dr. Niu Hao (2010; with Prof. Zhou, Dalian U. of Technology): Environmental Management, Beijing, China
Dr. Hua Cai (2015; with Prof. Ming Xu, School for Environment and Sustainability): Prof., Purdue U.
Dr. Dimitris Assanis (2016; with Prof. Margaret Wooldridge, Mechanical Eng.), Postdoc, U. Delaware
Ms. Ping Chen (with Prof. Ming Xu, School for Natural Resources & Environment; 2018)
Lt Col Dennis Sugrue (Expected graduation 2021)
Ms. Mingyan Tian (Expected graduation 2023)
Mr. Kenneth Chung (Expected graduation 2023)
Ms. Dan Li (Expected graduation 2024)

Visiting Research Scientists:
Damborsky, Jiri (6/96-8/96): "Molecular Descriptors for Dioxin Dechlorination Activity". Visiting from the Laboratory for Molecular Computations, Masaryk University, Brno, Czech Republic
Kuty, Michal (6/96-8/96): "Molecular Descriptors for Dioxin Dechlorination Activity". Visiting from the Laboratory for Molecular Computations, Masaryk University, Brno, Czech Republic
Lendvay, John (5/00-8/00 and 5/01-6/01):"Field Implementation of a Halorespiration Barrier at the Bachman Road Residential Wells Site" Visiting from the University of San Francisco, Department of Environmental Science.

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https://www.researchgate.net/profile/Peter_Adriaens2
https://www.difin.io

Deborah de Lange (2013-14): "Industry ecosystems for smart grid deployment", Visiting from Ryerson University (Toronto, Canada) – Ted Rogers School of Management.
Antti Tahvanainen (2014-15): "Financial Technology for Industrial Renewal", Visiting from the Research Institute of the Finnish Economy, Helsinki, Finland.

Short Courses:
Smart Infrastructure and Data-Driven Financing Models, Exec Ed. Course, Aalto University, London, UK (April 2019)
Design of Green Investment Funds and Endowment for the Great Lakes Basin, Conference of Great Lakes and St. Lawrence Governors and Premiers, Evanston, IL (July 2016)
Green Industry Clusters for Economic Development, Taipei, Taiwan (2016; 30 attendees)
CleanTech Entrepreneurship Executive Education Program, Collaboration with Aalto University (Helsinki, Finland) and UMORE (Shanghai, China), Zhangjiang Hi-Tech Park, Shanghai, China (May 2016)
Financial Innovation Academy: Multi-Asset Renewal Fund (MARF), Research Institute for the Finnish Economy and Aalto University, Helsinki, Finland (2015)
Michigan Green Technology Entrepreneurship Academy (M-GTEA), Grand Rapids, MI (2011-2012).
Business of Sustainability and CleanTech Entrepreneurship, Suzhou Institute of Sichuan University, Suzhou, China ('09: 30 students; '10: 70 students)
International Summer School "Biomonitoring, bioavailability and microbial transformation of pollutants in sediments and approaches to stimulate their biodegradation", Genoa, Italy (9/12/05/-9/14/05)
Biological Processes for Sustainable Water Use, Veracruz, Mexico (8/11/05-8/14/05), Lecturer
Soil and Sediment Sampling Design and Methods, Ann Arbor, MI (5/10/04-5/14/04), Course Director
3rd Sustainable Potable Water Short course, Aut. University Mexico, Mexico City, 9/02, Plenary lecturer.
NSF Pan-American Advanced Study Institute, Rio de Janeiro, Brasil, July 22-August 2, 2002 (co-PI and lecturer; Danny Reible, LSU, PI)
NATO Advanced Study Institute, Prague, Czech Republic (2001) (lecturer; Danny Reible, LSU, PI)
International Applied Environmental Geochemistry (AEG) Masters Course (20-35 students), University of Tuebingen (Germany), Microbiology I Module: April 14-18, 2000, Microbiology II Module: November 17-21, 2000, Microbiology I Module: April 18-20, 2001, Microbiology II Module: November 26-29, 2001., Microbiology II Module: 11/02, 11/03, 02/05, 11/05, 11/06.
Environmental Microbiology: Fundamentals and Applications (30 participants), Czech Academy of Sciences; Prague, Czech Republic; June 6-13, 1998 (organizer and lecturer)

Research Grants and Contracts

Current and Pending:
ERC Preproposal (NSF). Smart Infrastructure Design to enable Equity, Wellness, Accessibility, Liquidity and the A.I. Knowledge economy (with Stanford University, University of Central Florida, Illinois Institute of Technology). (UM co-PIs: Jerry Lynch and Mingyan Liu; Stanford co-PI: Nicole Ardoin; UCF co-PI: Debra Reinhard). Pending
LEAP-HI (NSF). Design Metrics and Data Valuation Strategies to Scale Financing of Intelligent Infrastructure Systems (with Jerome Lynch, Branko Kerkez and Andrew Wu UM; Matthew Dixon, IIT). Pending
Ford URP. Business Models for Autonomous Vehicles and Infrastructure, $200K (with Yafeng Yin), 01/01/21-06/30/22.
Great Lakes Protection Fund. Financial Mechanisms and the Conditioning of Lending and Capital Flows in Agriculture Supply Chains for Farm-Based Nutrient Performance, $150K (with Jon Allan and Ravi Anupindi, UM; David LeZaks, Croatan Institute)
Nuveen. Smart Infrastructure Finance Center Partnership Fixed Income Products ESG Strategy, $150K (with LimnoTech, subcontract), 9/1/20-8/31/21.
Ripple. UM – FinTech Collaboratory and Center for Smart Infrastructure Finance ($1M, PI, 2 Co-PIs), 01/01/19-12/31/20.

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Completed:

REFRESCH: Researching Fresh Solutions to the Energy/Water/Food Challenge in Resource-Constrained Environment. Phase II. (co-PI, Other PIs: Schwank (ChE); Barteau (ChE); Savage (ChE); Huang-Saad (BME, CfE); Fisher (ChE); Miller (SNRE); Scavia (Graham Institute); Hoffman (RSB, SNRE); Hill (Architecture and Urban Planning); $3 M.; Start/End: 05/01/13-10/31/16

The Ford Motor Company, New Mobility Industry Value System Analysis ($100K; with Sue Zielinski), 01/01/14-06/30/17.

The Ford Motor Company, Design of a Global Mobility Databank: Deal Sourcing and Use Case Design ($100K; with Sue Zielinski), 01/01/14-06/30/17.

Finnish Innovation Fund (Helsinki, Finland). Financial Innovation for Industrial Renewal: Multi-Asset Fund Structuring and Design. $ 2.0 MM, 01/01/14-09/30/16.

American Jobs Project (sponsor: JPB Foundation, New York). Design of CleanTech Clusters in 10 Manufacturing States (PI: Jennifer Granholm); $500K ($20K, Adriaens); Start/End: 05/15/15-11/15/15.

National Collegiate Inventors and Innovators Association (NCIIA). SMART E-Team Course: Reverse Innovation Ventures in New Mobility (with Sue Zielinski, UM), 7/31/13-12/31/14. $35K.

NSF Workshop. Integrating Economic and Financial Principles into Environmental Engineering Research and Education, Co-PI (with G. Characklis, UNC), 10/01/10-06/30/13; $50K., Current.

The Dow Chemical Company. Michigan Dioxin Exposure Study, 3/1/04-12/31/10, Co-PI $15 M. ($ 2.7M to co-PI)

MEDC/Sakti: Sustainable Supply and Recycling of Electric Vehicle Battery Constituent Metals (with Christian Lastoskie), $500,000.

SERDP. Integrating Uncertainty Analysis in Risk Assessment for In Place Contaminated Sediment Strategies, $1,427,000 (1/1/05-12/31/08), PI (Co-PIs: LimnoTech, Inc., Steven Wright).

SERDP. Optimization of iron sulfide –based reactive barriers. Co-PI (PI: Hayes; Co-PIs: Abriola, Olsen, Demond), $1,100,000.

EPA-STAR. Development of Re-Usable Fuel Cells, 9/1/2004-12/31/2007, PI $150,516.

Michigan Tri-Corridor Fund. Development of a prototype micro-integrated flow cytometer, $400,000; 9/1/04-8/31/06; Co-PI and consultant (with Steven Skerlos, ME, Jennifer Beard, Accuri Cytometers).

The Dow Chemical Company. Technology Benchmarking Workshop for Remediation of Dioxin-Contaminated Sediments, 1/1/04-8/31/04, PI, $65,000.

U.S.EPA/Navy: "Pearl Harbor Dioxin and PCB-Contaminated Sediments: Technology Demonstration", 10/1/02-12/31/03; $650,000, co-PI (with LimnoTech, Inc. Ann Arbor, MI); UM portion $162K.

Chlorine Chemistry Council: "Quantification of dioxin dechlorination and outgassing fluxes in urban waterways", 5/1/00, gift for dioxin research; $ 50,000 PI (with Prof. K. Jones, Lancaster University, UK).

NOAA-Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET): "Technology Development for Contaminated Coastal and Estuarine Environments: Hydrogen-Enhanced Remediation of Capped and Natural Sediments"; 9/1/01-8/31/03; $200,030; PI (Co-PI: Cyndee Gruden, CEE, and John Hull, Aquablok, Ltd.).

Taiwan Government, NSF, UM, Ford: "Sensing, Control and Optimization of Metalworking Fluids Recycling: Microbiological Component (with Steven Skerlos, Mechanical Engineering; Kim Hayes, CEE; Richard Brown, Electrical Engineering and Computer Science); > $ 1 m. (3 years); Co-PI.

Michigan Department of Environmental Quality (MDEQ), "Remediation of Chlorinated Solvents at the Bachman Road Site Using Innovative Technologies: Surfactant Enhanced Remediation and Halorespiration, Phases II and III-Adjustment", 1/1/99-9/30/02; $ 350,000, PI (Co-PIs: Linda Abriola, Mike Barcelona, Babu Fathepure, Kim Hayes, James Tiedje, Frank Loeffler, Kurt D. Pennell, Erik Petrovskis, and Robert Hickey).

NSF; "Propagation of Uncertainty in the Field Extrapolation of Laboratory Experiments: Application to Dioxin-Contaminated Sediments", 9/1/99 - 8/31/02; TDC: $233,851, IDC: 101,813, Total: $335,664 Co-PI (PI Pierre Goovaerts)

ONR, "Effect of Hydrogen on Microbial Community Structure and Dechlorination Potential of Marine and Estuarine Sediments", 3/1/99-10/28/02, $350,000 (PI).

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USEPA/DOE/NSF/ONR, Assessment of Biotic and Abiotic Processes Controlling the Fate of Chlorinated Solvents in Mixed Waste Under Iron and Sulfate Reducing Conditions Using Laboratory and Field Microcosms, 1/1/98-12/31/01; 97-2463; $ 499,988; Co-PI with Kim Hayes and Michael Barcelona.
Michigan Department of Environmental Quality (MDEQ), "Remediation of Chlorinated Solvents at the Bachman Road Site Using Innovative Technologies: Surfactant Enhanced Remediation and Halorespiration, Phases II and III", 1/1/99-12/31/99; $ 1,549,538, PI (Co-PIs: Linda Abriola, Mike Barcelona, Babu Fathepure, Kim Hayes, James Tiedje, Frank Loeffler, Kurt D. Pennell, Erik Petrovskis, and Robert Hickey).
National Science Foundation - Center for Microbial Ecology (MSU; James Tiedje, Director): "Ecological and Kinetic Distribution of Soil Microbial Communities"; 8/1/92-4/30/99; $ 120,000, PI.
NIH (National Institutes of Health): "Cellular Biotechnology Training Program"; 7/1/96-6/30/01; $ 3,260,219; Co-I , David Friedman (UM, PI).
Office of Naval Research, "Natural and Enhanced Transformation of Polychlorinated Dibenzo-p-Dioxins in Estuarine and Marine Sediments", 1/1/96-2/28/99; $ 185,000; PI, Andrei Barkovskii (Co-PI).
Michigan Department of Environmental Quality (MDEQ), "Remediation of Chlorinated Solvents at the Bachman Road Site Using Innovative Technologies: Surfactant Enhanced Remediation and Halorespiration", 3/1/96-12/31/98; $ 850,000, PI, Babu Fathepure (Co-PI).
National Council of the Pulp and Paper Industry for Air and Stream Improvement (NCASI); "Natural and Enhanced Dechlorination of 2,3,7,8-Tetrachlorinated Dioxins and Dibenzofurans in Biological Solids", 2/1/98-7/31/98; $ 30,000, PI.
EPA-Great Lakes Mid Atlantic Hazardous Substance Research Center and DoD; "Investigations of Abiotic and Biotic Reductive Dechlorination Processes in Anaerobic Subsurface Systems", 6/1/96-5/31/98; $158,000; PI, Kim F. Hayes (Co-PI).
EPA-Great Lakes Mid Atlantic Hazardous Substance Research Center; "Metabolic and Cometabolic Biodegradation Kinetics Under Variably Saturated Conditions: Correlations with Water Potential and Moisture Content", 6/1/97-5/17/98; $ 118,718; PI.
University of Michigan, Program to Promote International Partnerships: “Development of Molecular Descriptors for Dioxin Dechlorination Activity”, 1997-98; $ 5,000; with Masaryk University, Czech Republic, PI.
U.S. Army Corps of Engineers Waterways Experiment Station, "Effects of Polycyclic Aromatic Hydrocarbons (PAH) on Reductive Transformation of Polychlorinated Dibenzo-p-Dioxins (PCDD) in Dredged Sediments", 4/1/96-1/31/97; $ 58,000; PI.
U.S. EPA, "Anaerobic Transformations of Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans as a Bioremediation Strategy for Passaic River Sediments", 6/1/95-5/30/96; $ 92,105. PI.
U.S. EPA, "Intrinsic Bioremediation at the Aquifer-Surface Water Interface (St. Joseph, MI)", 11/1/93-5/17/95; $ 131,579; PI, Nikolaos Katopodes (Co-PI).
EPA-Great Lakes Mid Atlantic Hazardous Substance Research Center /DoD "Intrinsic Bioremediation of Chlorinated Solvents at an Aquifer-Surface Water Interface (St. Joseph, MI)", 6/1/95-5/17/97; $ 140,680; PI.
EPA-Region II Superfund Research; "Anaerobic Transformation of Highly Chlorinated Dibenzo-p-Dioxins and Dibenzofurans", 10/1/93-9/30/94; $ 91,500; PI.
U.S. EPA-SERDP (Strategic Environmental Research and Development Program) "Phase I of Bioremediation Field Initiative at Wurtsmith Air Force Base"; 6/1/93-5/31/95; $690,482; Co-PI, Walter J. Weber, Jr. (PI), and Linda M. Abriola (Co-PI).
US-EPA, "Intrinsic Bioremediation at Fire Training Area FT-2 (Wurtsmith AFB, MI)"; 5/18/95-8/31/96, $ 60,000; PI.
U.S. EPA-SERDP, "Monitoring and Predicting In Situ Bioremediation Using Microbial and Geochemical Indicators", 5/1/95-4/30/97; $ 216,000; Co-PI, Larry Forney (MSU, PI), Frank Chapelle and Sheridan Haack (U.S. Geological Survey, Co-PIs).
U.S. EPA-Great Lakes Mid Atlantic Hazardous Substance Research Center; "Fundamentals of Bioavailability. Sub-project: The Effect of Water Potential on Biodegradation in the Unsaturated Zone"; 6/1/95-5/15/97; $ 72,000; PI.
U.S. EPA. "A Computer Program to Model Bioventing of Organic Contaminants in Unsaturated Geological Material"; 9/1/93-9/1/95; $200,000; Co-PI, Linda.M. Abriola (PI).

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U.S. EPA-Great Lakes Mid Atlantic Hazardous Substance Research Center; "Fundamentals of Bioventing", 6/1/94-5/17/95; $ 35,000. PI.
NIEHS (National Insitute of Environmental Health Sciences; "The Mechanism of Reductive Dechlorination"; 4/1/92-3/31/95; $320,732; PI.
NIEHS; "Health Hazards from Groundwater Contamination-UM Trainee core"; 4/1/92-3/31/95; $ 97,640; Co-I (P.I.: Lawrence Fisher, MSU).

Invited Presentations and Activities:

1. Asset Tokenization: A Blockchain Solution to Financing Infrastructure in Emerging Markets and Developing Economies (with Yifeng Tian, UF). Fintech To Enable Development, Investment, Financial Inclusion, And Sustainability. Singapore/Philippines, September 22, 2020.
2. Pricing Water Risk: Analytics of Interest to Institutional Investors and Their Holdings, Water and Long-Term Value Conference, San Francisco, CA, December 10, 2020.
3. Assessing Water Risk: Institutional Investment in Water Management Innovations. Water and Long-Term Value Conference, San Francisco, CA, December 10, 2019.
4. Understanding natural capital risk assessments in portfolio analysis, Key-note Lecture, Natural Capital Conference, London, UK, November 24-25, 2019
5. Digital Financing of Smart Infrastructure, CECE Distinguished Lecture, Texas Tech, November 4, 2019
6. Digital Financing Models for Transportation Infrastructure and Beyond, Bermuda Tech Week, Bermuda (10/19).
7. Ripple University Blockchain Research Initiative (UBRI), UC Berkeley, October 2-4, 2019
8. InfraTech: Blockchain-Based Financing Solutions for Cyber-Physical Infrastructure Systems. SAMSI Workshop on Foundations for Blockchain Data Analytics, October 6-7, 2019
9. Capital Markets Risk Signaling: Linking Financial Asset Risk Pricing to Water Risk Exposures, Financial Risk Accounting Perspectives, Helsinki, Finland (09/19)
10. waterBeta: An asset management approach for water risk in equities, CSR Investment Conference, S-Network Global Indexes, New York, NY (07/19)
11. A 'Moneyball' Approach to Closing the $2 Trillion Infrastructure Finance Gap: InfraTech, Data, and Financial Innovation, Stanford University (07/19)
12. Infrastructure Innovation Tour Roundtable Discussion, University Research Consortium, Wayne State University, Detroit (06/19)
13. Smart Infrastructure Finance: Opportunities for Municipalities, Plante Moran/OHM Meeting on municipal investment. Livonia, MI (06/19)
14. Efficient Financing of Smart Infrastructure: Will Digital Finance Open the Floodgates?, AEESP, University of Arizona, Tempe AZ (05/19)
15. Data-Driven Financing Models for Mobility, Deloitte-World Economic Forum meeting, Detroit (10/18)
16. Smart Infrastructure Finance, University of Central Florida (11/18), Stanford University (12/18), Illinois Institute of Technology (12/18)
17. Private Investment in Public Infrastructure. Center on Finance, Law and Policy (10/18)
18. Data-Driven Business Models in CleanTech. Evening seminar and discussion for the student investment members of the Wolverine Venture Fund and Lurie Commercialization Fund, Ross School of Business (03/18)
19. Smart Infrastructure: The Case for Data Monetization. Brown bag seminar, Center for Finance, Law and Policy, Law School (02/18)
20. FinTech - Not Just About Bitcoin. Seminar to the University of Michigan Student FinTech Club, Ross School of Business (01/18) Smart Infrastructure Finance: Finance and Business Models in the Data Economy. University of Toronto, Ontario, Canada (01/18)
21. Financing sustainable cities: Plenty of money - lack of investment models. Keynote presentation at the UN-DESA High Level Finance Conference on the Implementation of the 2030 Agenda for Sustainable Development, Doha, Qatar (11/17)
22. Business Water Risk: Ripple Effects from Watersheds to Capital Markets, ESEP Seminar (EWRE) (01/17)
23. Multi-Asset Funds to Finance Sustainability, GLOBE Capital 2017, Toronto, ON (04/17)

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24. Capital Markets Risk Signaling for Water Risk, Ceres17 Annual Conference “Sustainability is the Bottom Line”, San Francisco, CA (04/17)
25. Financial Innovation as a green growth policy instrument, University of Michigan Center for Finance, Law and Policy (01/17)
26. Global Sustainability Summit and P80 Foundation; Little Rock, AR (12/16) ZurichRe and swisscleantech; FinTech meets CleanTech, Zurich, Switzerland (11/16)
27. Taiwan Green Trade Office and Think Tank (invitation from Finance Minister Chen); Rapid Identification and Allocation of Assets for a Green Economy, Taipei, Taiwan (05/16)
28. Association of Environmental Engineering and Science Professors, Grand Challenges Workshop, Rice University, Houston, TX (05/16)
29. Multi-Asset Renewal Fund Structuring and Risk Assessment: Case Studies for Greening Economies. Global CleanTech Cluster Association (GCCA) and Taiwan Green Trade Conference, Taipei, Taiwan (11/15).
30. Positioning Growth Firms in the Green Chemistry Industry Ecosystem: The Antwerp-Ruhr-Rhein Chemical Megacluster. Brussels Sustainable Development Summit, Belgium (10/15).
31. Emerging Industry Ecosystem Structure: A Bloomberg View of Smart Grid and New Mobility. Global CleanTech Summit, Helsinki, Finland (09/15). With Antti Tahvanainen, Research Institute for the Finnish Economy.
32. Design of Multi-Asset Funds for Industrial Renewal: Tools and Use Cases. Global CleanTech Summit, Helsinki, Finland (09/15). With Antti Tahvanainen, Research Institute of the Finnish Economy.
33. Business Water Risk: Leading Indicator for ESG-Based Investment Allocations, NASDAQ ESG meeting, New York, NY (06/15)
34. Multi-Asset Renewal Funds for Green Growth: A New Long-Term Investment Fund Approach? KBC Wealth Management, Brussels, Belgium (05/15)
35. Innovation in an Unbundling Economy, M-TRAC Program, East Lansing, MI (03/15)
36. Multi-Asset Renewal Funds for Green Growth, Global CleanTech Cluster Association Conference, Lausanne, Switzerland (12/14)
37. Positioning Companies for Value Capture and Investability, CleanTech Roundtable, Singapore (10/14)
38. Investment Typology for Companies: KeyStone Compact Assessment Platform, Industry & Innovative Sustainable Production (iSUP), Antwerp, Belgium (09/14)
39. Bridging Physical and Financial Risk from Water: A Portfolio Perspective. Argonne National Laboratory (Technology Policy Office), Washington, DC (04/14)
40. Scaling Regional CleanTech, KeyNote at State Department Conference on ‘Global Solutions’ (04/14)
41. KeyStone presentation/workshop, Flemish CleanTech Association, Antwerp, Belgium (02/14)
42. Evolutions in Sustainability Finance, GLOBE 2014, Vancouver, CA (03/14)
43. Scandinavia CleanTech Open, Malmoe, Sweden (03/14)
44. KeyStone presentation and workshop, Flemish CleanTech Association, Antwerp, Belgium (02/14)
45. SouthEast Michigan Economic Forum, Ann Arbor, MI. (11/13)
46. KeyStone Compact workshop, Singapore CleanTech MarketPlace, Singapore (09/13)
47. KeyStone Compact keynote, CleanTech Venture Day, Malmoe, Sweden (05/13)
48. TEDx talk on “Reverse Innovation”, CleanTech Forum Bilbao (04/13)
49. Global CleanTech Cluster Managers Ministerial Meeting (Dublin, Ireland) “Scaling Cleantech: Investing in Global Value Chains” (04/13)
50. Panel moderator, CleanTech Venture Day, Lahti, Finland (04/12)
51. UM-Ben Gurion University (Israel) Solar Workshop (02/12)
52. Keynote (with B. Taube, BLT Energy, Atlanta GA), CleanTech Clusters, Melbourne, Australia (2/12)
53. Keynote lecture ‘Business Water Risk’, Gordon Research Conference, New Hampshire (06/12)
54. The Berkeley Roundtable on the International Economy (BRIE), Berkeley, CA (04/12)
55. Value Chain Investing, CleanTech Venture Day, Espoo/Lahti, Finland (04/12)
56. Solar-Water Nexus Workshop, Ben Gurion University of the Negev, Israel (02/12)
57. CleanTech Investment Forum (Terrapin), Melbourne, Australia (02/12)
58. University of Gent, Department of Agricultural and BioEngineering, Belgium (11/11)

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59. Low Carbon Investment Conference, London, UK (11/11)
60. Dublin CleanTech Forum, Enterprise Ireland (11/11)
61. EcoCities Investment Conference, Montreal, Canada (08/11)
62. Asia-Pacific Investment CleanTech Investment Conference (07/11)
63. Asia Business Leaders Sustainability Conference, Singapore (10/11)
64. School of Civil, Environmental & Transportation Eng., University of Florida, Gainesville (04/11)
65. Dalian University of Technology, Dalian, China (03/11)
66. National Chung Hsing University, Taichung, China (10/10)
67. International Symposium for Environmental Biotechnology, Rimini, Italy (09/10)
68. Dalian Institute of Technology, Key-Note Lecture for Friendship Prize, Dalian (12/09)
69. Roundtable on Entrepreneurship Education, Chinese University of Hong Kong, China (10/09)
70. World Resources Institute, Beijing, China (08/09)
71. World Bank Mission, Manila, Philippines (06/09)
72. World Bank, Environment Sector Unit, Washington DC (05/09)
73. Taihu Basin Authority, Shanghai, China (05/08)
74. Suzhou Institute of Sichuan University, Suzhou, China (10/08, 12/08, 03/08)
75. Suzhou-Singapore Technology Park, Suzhou, China (08/08)
76. CleanTech Investment Conference and Trade Show, Boston, MA (05/08)
77. Ontario Center for Research and Innovation, Ottawa, ONT, Canada (06/08)
78. Arizona State University, Tempe, AZ (2/08)
79. University of California Riverside, Riverside CA (2/08)
80. CleanTech Venture Investment Conference, Toronto, ONT, Canada (9/07)
81. Key-Note Presentation, Environmental Nanotechnology, Taiwan National University, Taiwan (5/07).
82. Swiss Federal Water Research Institute (EAWAG), Zuerich, Switzerland (11/06)
83. UNEP Africa Stockpile Program, Rolle, Switzerland (11/06)
84. Department Civil and Environmental Engineering – UCLA, Los Angeles, CA Seminar on Microbial Sensing: Micro- to Macro-Scale Application (12/06)
85. Applied Research Center, Florida International University, Miami, FL (10/06)
86. Dalian Institute of Technology, Dalian, China, Key-note lecture (9/06).
87. International Symposium on Environmental Biotechnology (ISEB), Leipzig, Germany, Key-note: “Micro-Integrated Flow Cytometry: Application for Groundwater Characterization.” (7/06).
88. Brookhaven National Laboratory, New York, NY (2/06)
89. Great Lakes Environmental Research Laboratory, Ann Arbor, MI (11/05)
90. East Coast Conference on Contaminated Soils and Sediments, American Society for Environmental Health Science (AEHS), Amherst, MA (10/05).
91. Public Broadcasting Documentary on Green Roof Technology and Policy, Washington, DC (4/05)
92. Department of Civil and Environmental Engineering, Rice University, Houston, TX (3/05)
93. Dioxin 2004 – Environmental Exposure Assessment/Fate and Transport, Berlin, Germany (9/04)
94. SERDP/ESTCP Workshop on Contaminated Sediments, Charlottesville, VA (8/04)
95. International Symposium for Environmental Biotechnology (ISEB), Chicago, IL (6/04)
96. Brominated Flame Retardants (BFR) 2004 – Risk Characterization and Communication, Toronto, Ontario, CANADA (6/04)
97. CONCARIBE 2004 – Helping Caribbean Nations Towards Sustainable Development, Cartagena, Colombia (5/04)
98. Remediation Technologies Development Forum (RTDF) on Sediments, Baltimore, MD (2/04).
99. School of Civil and Environmental Engineering, Purdue University, West Lafayette, IN (12/03).
100. East Coast Conference on Contaminated Soils and Sediments, American Society for Environmental Health Science (AEHS), San Diego, CA (10/03).
101. Key-Note, RISV-International Society for Environmental Biotechnology, Rimini, Italy (9/03).
102. Department of Applied Microbiology and Biotechnology, State University of Gent, Belgium (7/03).
103. Industrial Key-Note, West Coast Conference on Contaminated Soils and Sediments, American Society for Environmental Health Science (AEHS), San Diego, CA (3/03).
104. Cold Climate Bioremediation Program, University of Lund, Sweden, 1/03, Key-note.
105. Department of Geology, The University of Michigan (10/02).

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106. NSF Center for Micro Electro-Mechanical Systems, Guest Lecture on “Clean Water: Access, Use, and Sustainable Exploitation”, The University of Michigan, 9/02.
107. Remediation Technologies Development Forum on Contaminated Sediments and Groundwater-Surface Water Interfaces, Seattle, WA (10/02). Key-Note.
108. International Symposium for Subsurface Microbiology (ISSM), Copenhagen, Denmark, (9/02), Key-Note Presentation: “Miniaturization of Flow Cytometric Applications for Microbial Characterization in Complex Environmental Systems”.
109. 3rd International Symposium for Bioremediation and Biodeterioration, Prague, Czech Republic (7/02), Key-Note: “Characterization of Microbial Activities in Complex Systems”.
110. Lawrence Livermore National Laboratories, Environmental and Bioinformatics Divisions, Livermore, CA (6/02), Seminar “Micro-Integrated Flow Cytometry: Current Status and Applications”.
111. West Coast Conference on Contaminated Soils and Sediments, American Society for Environmental Health Science (AEHS), San Diego, CA (3/02).
112. Groundwater Research Institute, Technical University of Denmark, Lyngby, Denmark (11/01)
113. Departments of Civil and Environmental Engineering, Geological Sciences, and Plant and Soil Sciences, Michigan State University (1/01)
114. Industry-sponsored Key-Note Lecture, International Symposium for Environmental Biotechnology (ISEB)-2000, Kyoto, Japan (7/2000).
115. Department of Civil and Mechanical Engineering, McGill University, Montreal, Canada (7/2000)
116. Center for Biocatalysis, University of Iowa, Iowa City (3/2000)
117. Department of Environmental Science, Ohio State University, Columbus, OH (2/2000)
118. Keynote Lecture, Dechema Symposium on Natural Attenuation, Frankfurt am Main, Germany (10/99)
119. Swiss Federal Institute of Environmental Science and Technology, Department of Engineering, Duebendorf, Switzerland (9/99).
120. Lancaster University, Division of Environmental Science, Lancaster, U.K. (9/99).
121. Swiss Federal Institute of Technology, Institute of Soil and Water Management, Lausanne, Switzerland (4/99)
122. Swiss Federal Institute of Environmental Science and Technology, Department of Microbiology, Duebendorf, Switzerland (4/99).
123. The University of Bayreuth, Department of Microbiology, Bayreuth, Germany (3/99).
124. Swiss Federal Institute of Environmental Science and Technology, Department of Chemistry, Duebendorf, Switzerland (2/99).
125. University of California - Riverside, Department of Soil Science and Environmental Toxicology Program (10/98)
126. Stanford University, Department of Civil Engineering, Stanford, CA (9/98)
127. Institute for Geosciences, The University of Tuebingen, Tuebingen, Germany (7/98)
128. Second Conference on Biosorption and Bioremediation, Prague, Czech Republic (7/98)
129. Michigan Department of Environmental Quality - Annu. Mtg., Lansing, MI (5/98)
130. 3d Int. Symposium on Environmental Chemistry "Warszawa '98", Warsaw, Poland (4/98).
131. Society for Industrial Microbiology, Reno, NV (8/97).
132. International Symposium for Environmental Biotechnology (ISEB), Ostend, Belgium (4/97).
133. Medical University of South Carolina, Charleston, S.C. (10/96).
134. Charles University/Institute of Chemical Technology, Prague, Czech Republic (5/96).
135. Masaryk University, Department of Environmental Sciences, Brno, Czech Republic (5/96).
136. Key-Note Speaker, International NATO Workshop on Quantitative Structure-Activity Relationships (QSBR II), Luhacovice, Czech Republic (5/96).
137. University of Stuttgart and Fraunhofer Institute for Microbiology (12/95)
138. Swiss Federal Institute for Water Science Technology (EAWAG), Zuerich, Switzerland (12/95).
139. Rhone-Poulenc Organisation, Lyon France (12/95).
140. University of Amsterdam, Dept. Environ. Toxicology and Chemistry, The Netherlands (12/95).
141. National Environmental Research Institute (NERI), Roskilde, Denmark (12/95).
142. International Conference on Biosorption and Bioremediation. Prague, Czech Republic (10/95).

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143. Chair, Session on "Bioremediation of Chlorinated Aromatic Compounds", 15th International Dioxin Conference, Edmonton, Alberta, Canada (8/95).
144. 8th International C_1 Symposium, San Diego, California (8/95)
145. Oxychem Research and Development, Grand Island, NY (1995)
146. Michigan Biotechnology Institute, Lansing, MI (3/95)
147. Dow Chemical, Midland, MI. (1995)
148. 5th International Symposium on Environmental Research Topics (hosted by Dr. F.W. Karasek, Univ. of Waterloo), Phoenix, Arizona (1994)
149. US-EPA Bioremediation Risk Assessment Workshop, Duluth, Minnesota (1993)
150. Universität für Bodenkultur (University for Soil Sciences) - Vienna, Austria (1993).
151. DECHEMA Int. Symposium on "Soil Decontamination using Biological Processes", Karlsruhe, Germany (1992).
152. Dehalogenation Conf., "Anaerobic Dehalogenation and its Environmental Implications", Athens, Georgia (1992).
153. Institüt für Mikrobiologie, Universität Stuttgart, Germany (1990).
154. GBF, Gesellschaft für Biotechnologische Forschung, Braunschweig, Germany (1990).
155. Annual Forum for Applied Biotechnology, Gent, Belgium (1990).

Journal Publications (submitted, in review):

1. Mogosanu, I., C. Jiang, C. Liao, T. Slawecki and P. Adriaens. 2019. Capital Markets Risk Signaling: Linking Financial Asset Risk Pricing to Water Risk Exposures. J. of Indexing, Submitted.
2. Adriaens, P., R. Moya, S. Chen, and R. Hampshire. 2019. Data commodity swaps and pooled derivatives: Impact of data supply chains on monetization models in the smart mobility industry. Int. J. Production Economics. In Review.
3. Arnold, A., Jiang, C., Adriaens, P., Sinha, S. and Teener, A. 2020. A Capital Markets-Based Water Risk Assessment of Key Industrial Water Users in the Great Lakes Region: Indicators for Portfolio Managers. Available at SSRN: https://ssrn.com/abstract= In Preparation for J. Sustainability.
4. Kotiranta, A., A. Tahvanainen, M. Ritola, and P. Adriaens. 2019. Leveraging Physical Assets for Value Creation Through Cleanweb Firms: The Finnish Cleantech Space in Transition. Ross School of Business Paper No. 1279. Available at SSRN: http://ssrn.com/abstract=2611231. In preparation for submission to California Management Review.
5. Adriaens, P., K. Sun, C. Ouyang and R. Gao. 2019. Bridging Physical and Financial Business Water Risk: waterVar and waterbeta Metrics for Equity and Portfolio Risk Assessment. Ross School of Business Paper No. 1237. Available at SSRN: http://ssrn.com/abstract=2445580. Int. J. Business Economics, Re-write.

Journal Publications (published):

1. Sugrue, D.P. and P. Adriaens. 2021. Maritime Transport Efficiency to Inform Demand-Driven User Fees for Harbor Infrastructure. Journal of Waterway, Port, Coastal, and Ocean Engineering. Accepted for publication.
2. Sugrue, D., and P Adriaens. 2021. A data fusion approach to predict shipping efficiency for bulk carriers. Transportation Research Part E: Logistics and Transportation Review 149, 102326
3. Brand, M., K. Quesnel, P. Saksa, N. Ulibarri, A. Bomblies, L. Mandle, M. Allaire, O. Wing, J. Tobin-de la Puente, E.A. Parker, J. Nay, B. F Sanders, D. Rosowsky, J. Lee, K. Johnson, N. Gudino-Elizondo, N Ajami, N. Wobbrock, P. Adriaens, S.B. Grant, S. Wright, T. Gartner, Z. Knight, J. P. Gibbons. 2021. Environmental Impact Bonds: a common framework and looking ahead. Environmental Research: Infrastructure and Sustainability 1 (2), 023001.
4. Adriaens, P. and N. Ajami. 2021. Infrastructure and the Digital Economy: Impacts of Data on our Role in the Design, Financing, and Governance of Essential Services for Society. Journal of Environmental Engineering 147 (5), 02521001.
5. Tian, Y., P. Adriaens, R.E. Minchin, Z. Lu and C. Qi (2021). Asset Tokenization: A Blockchain Solution to Financing Infrastructure in Emerging Markets and Developing Economies. ADB-IGF Special Working Paper Series “Fintech to Enable Development, Investment, Financial Inclusion, and Sustainability. Available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3837703.

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6. Tian, Y., Z. Lu, P. Adriaens, R. E. Minchin, Y. Zhang, A. Caithness, and J. Woo. 2020. Financing Infrastructure Through Blockchain-Based Tokenization. Frontiers of Engineering Management 7 (4), 485-499.
7. Sugrue, D., A. Martin and P. Adriaens. 2020. Financial Network Analysis to Value Water Resource Risk Exposure of the Great Lakes Steel Industry. J. Infrastructure Systems, Journal of Infrastructure Systems 27 (1), 05020010.
8. Cai, H. X. Wang, P. Adriaens, and M. Xu. 2019. Environmental benefits of taxi ride sharing in Beijing. Energy 174, pp. 503-508.
9. Chen, Q. X. Jiang, E. Hedgeman, K. Knutson, B. Gillespie, B. Hong, J. M. Lepkowski, A. Franzblau, O. Jolliet, P. Adriaens, A. H. Demond, and D. H. Garabrant. 2013. Estimation of age- and sex-specific background human serum concentrations of PCDDs, PCDFs, and PCBs in the UMDES and NHANES populations. Chemosphere 91 (6), pp. 817–823.
10. Adriaens, P., B. Taube, and S. Lesser. 2012. The case for clustering. Global Environmental Politics, issue 3.
11. Towey, T.P., N. Barabas, A. Demond, A. Franzblau, D. H. Garabrant, B. W. Gillespie, J. Lepkowski, and P. Adriaens. 2012. Polytopic Vector Analysis of Soil, Dust, and Serum Samples To Evaluate Exposure Sources of PCDD/Fs. Environ. Toxicol. Chem. 31 (10), pp. 2191–2200.
12. Larson, W.L., P.L. Freedman, V. Passinsky, E. Grubb and P Adriaens. 2012. Mitigating Corporate Water Risk: Financial Market Tools and Supply Management Strategies. *Water Alternatives 5(3): 582-602.*
13. Characklis, G. W., P. Adriaens, J. B. Braden, J. Davis, B. Hamilton, J. B. Hughes, M. J. Small, and J. Wolfe. 2011. Increasing the Role of Economics in Environmental Research (or Moving beyond the Mindset That Economics = Accounting), Environ. Sci. Technol. 45, pp. 6235-6236.
14. Demond, A., A. Franzblau, D. Garabrant, X. Jiang, P. Adriaens, Q. Chen, B. Gillespie, W. Hao, B. Hong, O. Jolliet, J. Lepkowski. 2011. Human Exposure from Dioxins in Soil. *Environ. Sci. Technol., 46 (3), pp 1296–1302.*
15. Hao., N., C.E. Clark, J. Zhou, and P. Adriaens. 2010. Scaling of Economic Benefits from Green Roof Implementation in Washington DC. *Environ. Sci. Technol., 4 (11), pp 4302–4308.*
16. Hao., N., C.E. Clark, J. Zhou, and P. Adriaens. 2012. Impact of Cap and Trade Uncertainties on Green Roof Potential as an Energy Efficiency Technology. Energy Policy, In Review.
17. Demond, A., Towey, T., Adriaens, P., Zhong, X., Knutson, K., Chen, Q., Hong, B., Gillespie, B., Chang, S.-C., Franzblau, A., Garabrant, D., Lepkowski, J., Luksemburg, W., Maier, M. 2010. Relationship between polychlorinated dibenzo-p-dioxin, polychlorinated dibenzofuran, and dioxin-like polychlorinated biphenyl concentrations in vegetation and soil on residential properties. Environ. Toxicol. Chem. 29(12): 2660-8.
18. Franzblau A., Hedgeman E., Jolliet O., Knutson K., Towey T., Chen Q., Hong B., Adriaens P., Demond A., Garabrant D., Gillespie B., Lepkowski J. 2010. The University of Michigan Dioxin Exposure Study: A Follow-Up Investigation of a Case With High Serum Concentration of 2,3,4,7,8-Pentachlorobenzofuran. Environ. Health Pers. 118(9): 1313-1317.
19. Gillespie, B., Q. Chen, H. Reichert, A. Franzblau, E. Hedgeman, J. Lepkowski, P. Adriaens, A. Demond, W. Luksemburg, and D. Garabrant, 2010, Estimating population distributions when some data are below a limit of detection by using a reverse Kaplan-Meier estimator. Epidemiology, 21(4): S64-S70.
20. Franzblau, A., L. Zwica, K. Knutson, Q. Chen, S.-Y. Lee, B. Hong, P. Adriaens, A. Demond, D. Garabrant, B. Gillespie, J. Lepkowski, W. Luksemburg, M. Maier, T. Towey. 2009. An Investigation of Homes with High Concentrations of PCDDs, PCDFs, and/or Dioxin-Like PCBs in House Dust. J. Occup. Environ. Hygiene 6:3,188-199.
21. Chen, Q., D. Garabrant, E. Hedgeman, R. Little, M. Elliott, B. Gillespie, B. Hong, S.-Y. Lee, J. Lepkowski, A. Franzblau, P. Adriaens, A. Demond, and D. Paterson, 2010. Estimation of Background Serum 2,3,7,8-TCDD Concentrations by Using Quantile Regression in the UMDES and NHANES Populations. Epidemiology, 21(4): S51-S57.
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27. Franzblau, A., A. Demond, T. Towey, P. Adriaens, S.-C. Chang, W. Luksemburg, M. Maier, D. Garabrant, B. Gillespie, J Lepkowski, C.-W. Chang, Q. Chen, B. Hong. 2009. Residences with Anomalous Soil Concentrations of Dioxin-Like Compounds in Two Communities in Michigan, USA: A Case Study. Chemosphere, 74 (3): 395-403.
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32. Goovaerts, P., H. T. Trinh, A. H. Demond, T. Towey, S.-C. Chang, D. Gwinn, B. Hong, A. Franzblau, D. Garabrant, B. W. Gillespie, J. Lepkowski, and P. Adriaens. 2008. Geostatistical Modeling of the Spatial Distribution of Soil Dioxin in the Vicinity of an Incinerator: 2. Verification and Calibration. Environ. Sci. Technol., 42(10); 3655-3661.
33. Clark, C.E., P. Adriaens, and B. Talbot. 2008. Green Roof Valuation: A Probabilistic Economic Analysis of Environmental Benefits. *Environ. Sci. Technol., 42 (6), 2155–2161.*
34. McCormick, M.L., M. Gerdenich, and P. Adriaens. 2011. Biogenesis of nano-scale magnetite during reduction of two-line ferrihydrite by *Geobacter metallireducens*. Geochim. Cosmochim. Acta. In Review.
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36. Vannela, R., and P. Adriaens. 2007. In Vitro Selection of Hg (II) and As (V)-Dependent RNA-Cleaving DNAzymes*, Env. Eng. Sci., 24, 73-84.*

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Editorial Activities

California Management Review (CMR); Journal of Contaminant Hydrology (2000-2003)

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Review 6-8 manuscripts (Applied and Environmental Microbiology, Environmental Science and Technology, Applied Microbiology and Biotechnology, Water Resources Research, Environmental Toxicology and Chemistry, Bioremediation Journal), and 3-5 proposals (EPA, USDA, NSF, Michigan Great Lakes Protection Fund) per semester.

Litigation Expert Witness Work

Clark Hill/Strassburger, Houston, TX (2020): Patent Infringement and Interference
Gibson, Dunn & Crutcher LLP, Washington, DC (2013-2016): Patent Infringement and Interference
Baker & Hostettler LLP, Washington, DC (2013): Environmental Liability Assignment
Sive, Paget & Riesel LLP, New York, NY (2011-2015): Environmental Liability Assignment
Latham & Watkins LLP, San Francisco, CA (2007-2011): Environmental and Public Exposure Liability
King & Spalding LLP, Atlanta GA (2008-2012): Patent Infringement and Interference
Varnum, Riddering, Schmidt & Howlett, Attorneys-At-Law (Grand Rapids, MI), 1992-1996

Appendix B - Materials Considered

Bates Identified Documents

RPLI_SEC0026658
RPLI_SEC0090938
RPLI_SEC0265036
RPLI_SEC0296631
RPLI_SEC0301113
RPLI_SEC0302332
RPLI_SEC0302336
RPLI_SEC0302366
RPLI_SEC0509804
RPLI_SEC0541809
RPLI_SEC0546274
RPLI_SEC0554278
RPLI_SEC0555975
RPLI_SEC0574082

Litigation Materials

Plaintiff's First Set of Requests for Admission to Defendant Ripple Labs, Inc.

Plaintiff's Responses and Objections to Defendant Ripple Labs, Inc.'s First Set of Interrogatories

ECF No. 45 – Feb. 15, 2021 Joint Letter to Hon. Judge Analisa Torres

ECF No. 46 – First Amended Complaint

ECF No. 51 – Answer of Defendant Ripple Labs, Inc. to Plaintiff's First Amended Complaint

ECF No. 53 – Stipulation and Protective Order

ECF 123 - Memorandum Of Law In Support of Motion to Intervene

ECF 124-13 Exhibit M - XRP Ecosystem companies and applications

ECF No. 152 – Defendants' Response to Intervenor-Defendants' Motion to Intervene

ECF No. 153 – Plaintiff Securities and Exchange Commission's Memorandum of Law in Opposition to the Motion to Intervene

Deposition Materials

May 26, 2021 Deposition Transcript of David Schwartz

D. Schwartz Deposition Exhibit 9

D. Schwartz Deposition Exhibit 13

D. Schwartz Deposition Exhibit 14

Deposition Materials – cont.

D. Schwartz Deposition Exhibit 15

D. Schwartz Deposition Exhibit 18

D. Schwartz Deposition Exhibit 25

D. Schwartz Deposition Exhibit 27

D. Schwartz Deposition Exhibit 46

D. Schwartz Deposition Exhibit 77

June 23, 2021 Deposition Transcript of Asheesh Birla

Miscellaneous Materials

In re: Ripple Labs Inc. Wells Submission on Behalf of Ripple Labs Inc.

XRP Use Cases Spreadsheet (attached as Appendix C)

List of Third Party Use Cases Receiving Venture Capital and Founded after Ripple's Founding (attached as Appendix D)

Timeline of Ripple Products, Fundraising Rounds, and Accolades (attached as Appendix E)

Appendix C - XRP Use Cases Spreadsheet

List of XRP Use Cases		
Entity Name	**Category**	**Website**
000Webhost	Hosting Provider	https://www.000webhost.com/
1xBet	Casino/Online Betting	https://1xbet.com/
1xBit	Casino/Online Betting	https://1xbit.com/
24paybank	Cryptocurrency Exchange	https://24paybank.net/
2sync	Hosting Provider	https://www.2sync.co/
4ange	Cryptocurrency Exchange	https://4ange.me/
60cek	Cryptocurrency Exchange	https://60cek.org/
AavePay	Bill Payments	https://aave.com/
ABCC	Digital Asset Platform	https://abcc.com/en
Abucoins	Cryptocurrency Exchange	https://abucoins.com
Action Factory Inc. (d/b/a Stronghold)	Payment Gateways	https://stronghold.co/
Advcash (Advanced Cash)	Payment Gateways	https://www.advcash.com/
AEX.com	Cryptocurrency Exchange	https://www.aex.com/
Agoric Systems LLC	Smart Contracts	https://agoric.com/
AGRsicurezza	Consultancy	https://www.agrsicurezza.it/
AH Metal construction	Unclear	https://www.ahmetallbau.com/
AirVPN	VPN Hosting	https://airvpn.org/
ALFAcashier	Cryptocurrency Exchange	https://www.alfa.cash/
ALFAcoins	Payment Gateways	https://www.alfacoins.com/
alfatop	Mobile top-up	https://alfa.top/
All.Cash	Cryptocurrency Exchange	https://all.cash/direct/sberbank_rub-bitcoin_btc
Alphacat	Robo-advisor Marketplace	https://alphacat.io/
Alquicoche	Rental car booking site	https://www.alquicoche.es/
Alt 5 Sigma, Inc.	Cryptocurrency Exchange	https://alt5sigma.com/
Altcointrader	Cryptocurrency Exchange	https://www.altcointrader.co.za/
Alterdice	Cryptocurrency Exchange	https://alterdice.com/
Alternative Airlines	Air travel booking site	https://www.alternativeairlines.com/
AlysDax	Investments	https://alysdax.ltd/
AMLBot	AML support	https://amlbot.com/#~np1
Amun	Crypto ETP	https://amun.com/
Anchorage	Custody	https://www.anchorage.com/
Antalya Homes	Real Estate	https://www.antalyahomes.com/
ANX Pro	Wallet/Exchange	https://anxpro.com/
AnyCoin	Cryptocurrency Exchange	https://anycoindirect.eu/
Anypay	Payment App	https://anypayinc.com/
Arrington XRP capital	Digital asset management	http://arringtonxrpcapital.com/
As You Wish Bodywork LTD	Massage	https://www.massagebook.com/Denver~Massage~AsYouWishBodywork?utm_source=cryptwerk
AsiaMTM Group	Manufacturing, Trading, Marketing	https://asiamtm.com/
AstroPay	Payment Gateways	https://www.astropay.com/
Atomic Wallet	Payment Gateways	https://atomicwallet.io/
Autohaus-seidl.at	Physical car dealer	https://www.autohaus-seidl.at/
Azimo (ODL)	Money Transfer	https://azimo.com/
B1X	Micropayments	https://www.b1x.app/?v=7516fd43adaa
B2BinPay	Payment Gateways	https://b2binpay.com/
B2BX	Cryptocurrency Exchange	https://www.b2bx.exchange/
BaksMan	Cryptocurrency Exchange	https://baksman.org/
Balance	Custody	https://www.balancenow.ca/
Bank Frick	Custody, Trading	https://www.bankfrick.li/en/
Bankcomat	Cryptocurrency Exchange	https://bankcomat.org/en
BC Vault Hardware Wallet	Payment Gateways	https://bc-vault.com/
BC.Game	Casino/Online Betting	https://bc.game/home
BCB Group	Broker and Custodian	https://bcbgroup.io/
bcex	Digital Asset Platform	https://www.bcex.online/
BCHLX	Blockchain applications	https://bchlx.com/
Bcremit	Money Transfer	https://www.bcremit.com/
Beachhead	Game	https://beachhead.com/
Beeders	Payments	https://beeders.com/en/
BeeTech (ODL)	Money Transfer	https://www.beetech.global/
Belarusbank	Cryptocurrency Exchange	https://whitebird.io/
BelcoBTM	ATMs	https://belcobtm.com/

Beliani	Furniture	https://www.beliani.co.uk/
Beschriftungsprofi	Marketing services (lettering, etc.)	https://www.beschriftungsprofi.at/
BetcoinAG	Casino/Online Betting	https://www.betcoin.ag/
BetOnline.ag	Casino/Online Betting	mobile.betonline.ag
Bexpress pro	Payment Gateways	https://www.bexpro.ph/
Bgogo	Cryptocurrency Exchange	https://bgogo.com/
BHEX	Cryptocurrency Exchange	https://www.bhex.com/
bibox	Cryptocurrency Exchange	https://www.bibox.com/en
Bichip	Microchip	https://www.bichip.com/
Bidali	Purchase/Gift Card	https://www.bidali.com/
BigONE	Cryptocurrency Exchange	https://big.one/en
BiKi Exchange	Cryptocurrency Exchange; Crypto Backed Loans	https://www.biki.com/en_US/
Binance	Cryptocurrency Exchange	https://www.binance.com/en
Birake	Cryptocurrency Exchange	https://birake.com/
bit.Trade	Cryptocurrency Exchange	https://www.bit.trade/
BitAsset	Cryptocurrency Exchange	https://www.bitasset.com/
Bitbank	Cryptocurrency Exchange	https://bitbank.cc/en
Bitbay	Cryptocurrency Exchange	https://bitbay.net/en
Bitberry	Payment Gateways	https://bitberry.app/
Bitblinx	Cryptocurrency Exchange	https://bitblinx.com/
Bitbns	Cryptocurrency Exchange	https://bitbns.com/
BitBounce	Paid email service	https://bitbounce.com/
Bitcasino.io	Casino/Online Betting	https://bitcasino.io/
Bitcoin Suisse	Institutional-grade storage and exchange	https://www.bitcoinsuisse.com/
Bitcoin Superstore	Marketplace	https://bitcoinsuperstore.us/
bitcoin.co.id	Cryptocurrency Exchange	https://www.bitcoin.co.id/
Bitcoin.co.th	Cryptocurrency Exchange	https://www.bitcoin.co.th/
Bitcoin.travel	Travel booking site	https://bitcoin.travel/
Bitcoinbank	Cryptocurrency Exchange	https://bitcoinbank.co.jp/en
BitcoinTrade	Cryptocurrency Exchange	https://www.bitcointrade.com.br/pt-BR/
Bitex	Cryptocurrency Exchange	https://bitex.com/
BitExchanger	Cryptocurrency Exchange	https://bitexchanger.live/
Bitfi	Wallet	https://bitfi.com/
Bitfinex	Cryptocurrency Exchange	https://www.bitfinex.com/
BitFlip	Cryptocurrency Exchange	https://bitflip.li
bitflyer	Cryptocurrency Exchange	https://bitflyer.com/
bitforex	Cryptocurrency Exchange	https://www.bitforex.com/
Bitgild	Precious metals Marketplace	https://www.bitgild.com/
BitGo	Payment Gateways	https://www.bitgo.com/
Bithumb	Cryptocurrency Exchange	https://en.bithumb.com/
Bithunter	Cryptocurrency Exchange	https://bithunter.io/
BitInka	Cryptocurrency Exchange	https://www.bitinka.com/uk/bitinka/home
BitKeep	Wallet	https://bitkeep.org/
BitKiks	Purchase/Fashion Apparel	https://www.bitkiks.com/
Bitlish	Cryptocurrency Exchange	https://bitlish.com/
BitMarket	Cryptocurrency Exchange	https://BitMarket.pl
Bitmart	Cryptocurrency Exchange	https://www.bitmart.com/
Bitmax (AscendEX)	Cryptocurrency Exchange	https://bitmax.io/
BitMEX	Cryptocurrency Exchange	https://www.bitmex.com/
Bitnaru	Cryptocurrency Exchange	https://www.bitnaru.com/
Bitnovo	Payment Gateways	https://www.bitnovo.com/
BitOasis	Cryptocurrency Exchange	https://bitoasis.net/en/home
BITODDS	Casino/Online Betting	https://bitodds.io/home
Bitpanda	Cryptocurrency Exchange	https://www.bitpanda.com/en
BitPay	Payment Gateways	https://bitpay.com/
BitPrime	Cryptocurrency Exchange	https://www.bitprime.co.nz/
Bitrabbit	Cryptocurrency Exchange	https://bitrabbit.com/
Bitrue	Cryptocurrency Exchange	https://www.bitrue.com/
Bitsane	Cryptocurrency Exchange	https://Bitsane.com
Bitsblockchain	Cryptocurrency Exchange	https://bitsblockchain.net/
Bitsdaq	Cryptocurrency Exchange	https://bq.net/
Bitsler	Casino/Online Betting	https://www.bitsler.com/

Bitso	ODL Exchange	https://bitso.com/
Bitstamp	ODL Exchange	https://www.bitstamp.net/
BitStickers	Marketplace	https://bitstickers.net/
BitSure	Payments	https://bitsure.co/
Bittrex	ODL Exchange	https://bittrex.com/
Bittylicious	Cryptocurrency Exchange	https://bittylicious.com/
Bitvano	Cryptocurrency Exchange	https://bitvavo.com/en
Bitvolo	Payment Gateways	http://bitvolo.com/
bitz	Cryptocurrency Exchange	https://www.bitz.com/
Bixter	Cryptocurrency Exchange	https://bixter.org/
Black Cactus Global, Inc.	Advisory Firm	https://www.blgi.net/
blacksmith Unkelhäusser	Blacksmith	https://hufschmiede-unkelhaeusser.sta.io/
Blockchain Coffee	Purchase/Coffee	https://www.blockchaincoffee.space/home
Blockdaemon	Networking	https://blockdaemon.com/
Blockscart	Marketplace	https://blockscart.eu/
Bluzelle	Technology	https://bluzelle.com/
Boatsters Black	Yachts for Charter	https://boatstersblack.com/
Bolt Labs, Inc.	Cryptocurrency Exchange	https://boltlabs.tech/
BookcoinShop	Marketplace	https://bookcoinshop.com/
Booking.com	Hotel booking site	https://www.booking.com/
BookMauritiusHotels	Hotel Booking	https://www.bookmauritiushotels.com/
Bpay	Payments	https://bpay.com.au/
Bravsy	Travel agency	https://bravsy.com/
Braziliex	Cryptocurrency Exchange	https://braziliex.com/
BRD	Wallet	https://brd.com/
Bridge21	Cryptocurrency Exchange	https://bridge21.com/
Bronn Travel	Travel Agency	https://bronntravel.com.ua/
BTC38	Cryptocurrency Exchange	https://www.btc38.com/
BTC-Alpha	Cryptocurrency Exchange	https://btc-alpha.com/en/
btcbox	Cryptocurrency Exchange	https://www.btcbox.co.jp/
BTCC	Cryptocurrency Exchange	https://www.btcc.com/
BTC-E	Cryptocurrency Exchange	htteps://btc-e.nz
btcmarkets	Cryptocurrency Exchange	https://www.btcmarkets.net/
btc-trade	Cryptocurrency Exchange	https://btc-trade.com.ua/index.html
Btcturks	Cryptocurrency Exchange	https://www.btcturk.com/
BTCXIndia	Cryptocurrency Exchange	https://btcxindia.com/
Bullion79	Precious metals Marketplace	https://bullion79.com/
BuyBitcoin	Cryptocurrency Exchange	https://www.buybitcoin.ph
BuyUcoin	Cryptocurrency Exchange	https://www.buyucoin.com/
BuyWithCoins	Marketplace	https://www.buywithcoins.online/
BW.com	Cryptocurrency Exchange	https://www.bw.com/
bx.in	Cryptocurrency Exchange	https://bx.in.th
C2CX	Cryptocurrency Exchange	https://www.c2cx.com/
Cambridge Global Payments	Money Transfer	https://www.cambridgefx.com/home/
Cashaa	Cryptocurrency Exchange	https://cashaa.com/
Cashierest	Cryptocurrency Exchange	https://www.cashierest.com/
Cat.Ex	Cryptocurrency Exchange	https://www.catex.io/?load=1
Catalyst Corporate Federal Credit Union (ODL)	Financial Institution	https://www.catalystcorp.org/
CBX	Cryptocurrency Exchange	https://www.cbx.one/
CCXCanada	Cryptocurrency Exchange	http://ccxcanada.com/
Celsius Network	Lending	https://celsius.network/
Celtic Gold	Precious metals Marketplace	https://www.celticgold.eu/en/
CenterServ	Networking and Cloud management	https://www.centerserv.com/
cex.io	Cryptocurrency Exchange	https://cex.io/
Chainalysis	Blockchain Analysis	https://www.chainalysis.com/
Chainfront	API	https://medium.com/chainfront
Change Invest	Cryptocurrency Exchange	https://www.changeinvest.com/
ChangeHero	Cryptocurrency Exchange	https://changehero.io/
Changelly	Cryptocurrency Exchange	https://changelly.com/
ChangeNOW	Cryptocurrency Exchange	https://changenow.io/
Cinnamon	Micropayments/Tips	https://cinnamon.video/
Circle Internet Financial, Inc.	Cryptocurrency Exchange	https://www.circle.com/en/

Club Turismo	Travel agency	https://www.clubeturismo.com.br/
CME	Cryptocurrency Exchange	https://www.cmegroup.com/markets/cryptocurrencies.html
Cobo	Payment Gateways	https://cobo.com/
Codius	Smart Contracts	https://codius.org/
Coil	Micropayments/Tips	https://coil.com/about
Coin Cloud	ATMs	https://www.coincloudatm.com/
Coin Island	Payment platform	https://www.coin-island.com/
Coin Monster Store	Purchase/Fashion Apparel	https://coinmonster.store/
coin.z	Cryptocurrency Exchange	https://coin.z.com/jp/
Coinall	Cryptocurrency Exchange	https://www.coinall.com/
Coinbase	Cryptocurrency Exchange	https://www.coinbase.com/
Coinbene	Cryptocurrency Exchange	https://www.coinbene.com/
Coincheck	Cryptocurrency Exchange	https://coincheck.com/
CoinCorner	Payment Gateways	https://www.coincorner.com/
Coindeal	Cryptocurrency Exchange	https://coindeal.com/
CoinEgg	Cryptocurrency Exchange	https://www.coinegg.fun/
CoinEX	Cryptocurrency Exchange	https://www.coinex.com/
Coinfalcon	Cryptocurrency Exchange	https://coinfalcon.com/en/
CoinField	Cryptocurrency Exchange	https://www.coinfield.com/
CoinGate	Payment Gateways	https://coingate.com/
Coinhako	Cryptocurrency Exchange	https://www.coinhako.com/
Coinify	Payment Gateways	https://www.coinify.com/
CoinJar	Cryptocurrency Exchange	https://www.coinjar.com/
CoinLoan	Lending	https://coinloan.io/earn-interest/
Coinmate	Cryptocurrency Exchange	https://coinmate.io/home
CoinMe	Financial Services	https://coinme.com/
CoinMetro	Cryptocurrency Exchange	https://coinmetro.com/
Coinomi	Payment Gateways	https://www.coinomi.com/en/
Coinone	Cryptocurrency Exchange	https://coinone.co.kr/
CoinPayments	Payment Gateways	https://www.coinpayments.net/
Coinrail	Cryptocurrency Exchange	https://m.coinrail.co.kr/intro
Coins.ph	Payment Gateways	https://coins.ph/
Coinseed	Investments	https://www.coinseed.co/
CoinsPaid	Payment Gateways	https://coinspaid.com/
CoinSpot	Cryptocurrency Exchange	https://www.coinspot.com.au/
Coinsquare	Cryptocurrency Exchange	https://coinsquare.com/
Coinstart	Cryptocurrency Exchange	https://coinstart.nl/
coinsuper	Cryptocurrency Exchange	https://www.coinsuper.com/
CoinSwitch	Cryptocurrency Exchange	https://coinswitch.co/
Cointelegraph	Cryptocurrency news website	https://cointelegraph.com/
CoinTiger	Cryptocurrency Exchange	https://www.cointiger.com/en-us/
Cointopay	Payment Gateways	https://cointopay.com/
Cointree	Payment/Trading	https://www.cointree.com/
CoolWallet	Payment Gateways	https://www.coolwallet.io/
Corda Settler	Money Transfer	https://www.corda.net/
COSS	Cryptocurrency Exchange	https://www.coss.io/
Coworking Space Toronto	Coworking Space	website not working; cryptwerk only thing I'm finding online
Creative Click	Video/animation Productions	https://www.creativeclick.co/
Cred	Lending	https://mycred.io/what-is-xrp/
CROSS	Cryptocurrency Exchange	https://www.crossexchange.io/cross/home
Crumbs App	App	https://www.crumbsapp.com/
Crypterium	Wallet	https://wallet.crypterium.com/
Crypto Coffee	Marketplace	https://crypto-coffee.com/
Crypto Cove	Purchase/Fashion Apparel	https://cryptocove.io/
Crypto Emporium	Purchase/Fashion Apparel, Cars, Electronics	https://cryptoemporium.eu
Crypto Posters	Poster store	https://www.cryptocurrencyposters.com/
Crypto Shopper	Purchase/Fashion Apparel	https://cryptoshopper.store/
Crypto Voucher	Buy vouchers	https://cryptovoucher.io/
Crypto Whale Clothing	Marketplace	https://cryptowhaleclothing.com/
Crypto.com	Payment Gateways	https://crypto.com/en/pay.html
CryptoBox Trading	Cryptocurrency Exchange	https://cryptoboxtrading.com/

Cryptocurrency Checkout	Payment Gateways	https://cryptocurrencycheckout.com/
Cryptofacilities	Cryptocurrency Exchange	https://www.cryptofacilities.com/
Cryptoholic Shop	Purchase/Fashion Apparel	https://www.cryptoholicshop.com
Cryptojaunt	Travel Booking Platform	https://www.cryptojaunt.com/
Cryptolife	Marketplace	https://cryptolife-store.com/
Cryptomate	Cryptocurrency Exchange	https://cryptomate.co.uk/
Cryptonator	Payment Gateways	https://www.cryptonator.com/
cryptonex	Cryptocurrency Exchange	https://cryptonex.org/
Cryptopay	Wallet/Card	https://cryptopay.me/
Cryptopet	Marketplace	http://cryptopet.com/
Cryptosa	Advisory Firm	https://cryptosa.org/
CryptoSystems	Cryptocurrency Exchange	https://www.crypto-systems.com/
Cryptoworth	Advisory Firm	https://cryptoworth.app/
Cuallix (ODL)	Money Transfer	https://www.cuallix.com/en/
Cumberland	Cryptocurrency Exchange	https://cumberland.io/
DBS	Cryptocurrency Exchange	https://www.dbs.com/newsroom/dbs_digital_exchange
DCEX	Cryptocurrency Exchange	https://dcex.com/
Dcoin	Cryptocurrency Exchange	https://www.dcoin.com/
Deel	Payment Gateways	https://www.letsdeel.com/
Delphin hotel	Hotel	https://delphinhotel.com/
DEV	Online community	https://dev.to/
dex.openledger	Cryptocurrency exchange	https://openledger.info/portfolio/dex/
Diaz Plasencia y Asociados	Legal services	http://diazplasencia.com/
Digifinex	Cryptocurrency exchange	https://www.digifinex.com/en-ww/
Digital Currency Group	Blockchain investment group	https://dcg.co/
Digitec	Marketplace	https://www.digitec.ch/
Do You Space	Architecture firm	http://www.doyouspace.net/about-3/
DOBI	Cryptocurrency exchange	https://www.dobiexchange.com
Dokter Online	Online pharmacy	https://www.dokteronline.com/en/
Domitai	Payment Gateways	https://domitai.com/
DuckDice	Casino/Online Betting	https://duckdice.io/
Dunamu	Cryptocurrency exchange	https://dunamu.com/
Dynasty Goddess Hair	Hair extension shop	https://www.dynastygoddess.com/
Eat Me Clothing	Purchase/Fashion Apparel	https://eatmeclothing.com/
Ecstatic	Purchase/Fashion Apparel	https://ecstaticstore.com/
Ecwid	E-commerce hosting	https://www.ecwid.com/
Edge	Payment Gateways	https://edge.app/
eGifter	Purchase/Gift Card	https://www.egifter.com/buy-gift-cards-with-xrp
ElectroCat	Marketplace	https://www.electrocatstore.com/
Electrocoin	Payment Gateways	https://electrocoin.hr/en
Elite Card	Wallet/Card	https://elitecard.io/
Ellipal	Wallet	https://www.ellipal.com/
EnterBillions	Spam Blocker	https://enterbillions.co/
EO.Finance	Cryptocurrency Exchange	https://eo.finance/
Equilibrium Labs	Technology	https://equilibrium.co/
Eroscoin	Payment Gateway	https://eroscoin.org/
eToro	Cryptocurrency Exchange	https://www.etoro.com/en-us/
Euro Exim Bank (ODL)	Bank	https://www.euroeximbank.com/
Evident Proof	Data Verification/Proof Service	https://evident-proof.com/
Exarpy	Wallet	https://exarpy.com/
Exmo	Cryptocurrency Exchange	https://exmo.com/en
Exodus	Wallet	https://www.exodus.com/
Expedia	Travel booking site	www.expedia.com
Exrates	Cryptocurrency Exchange	https://exrates.me/
Extrutherm	Construction services	http://www.extrutherm.at/2018/
Exx	Cryptocurrency Exchange	https://www.exx.com/
FAMprint	Printing	https://www.fam-print.ch/
Fatbtc	Cryptocurrency Exchange	https://www.fatbtc.com/
fcce.jp	Cryptocurrency Exchange	https://zaif.jp/
Ferrum Network	Interconnectivity Network	https://ferrum.network/
Fetch Portraits	Photographer	https://www.fetchportraits.com/
FinFreeOTC	P2P Cryptocurrency Marketplace	https://finfreeotc.com/
FinNexus	Tokenization of assets	https://www.finnexus.io/

Flare Finance / Flare Networks	Smart Contracts	https://flare.xyz/
FlashFX (ODL)	Money Transfer	https://www.flash-fx.com/
Fliqpay	Payment Gateway	https://www.fliqpay.com/
Folgory	Cryptocurrency Exchange	https://folgory.com/
Fopay	Payment Gateways	https://fopay.io/
Forte	Gaming	https://forte.io
Frank and Beans	Purchase/Fashion Apparel	https://www.frankandbeans.com.au/
Free Wallet	Payment Gateways	https://freewallet.org/
Gala	Gaming	https://app.gala.games/
Galaxus	Marketplace	https://www.galaxus.ch/
Galaxy	Financial services	https://www.galaxydigital.io/
Galois Capital	Financial services	https://galois.capital/
Game Servers Today	Game server hosting	https://gameservers.today/
GamesOnly	Gaming	http://www.gamesonly.com/
Gas Aces	Gas and heat repairs	https://www.gasaces.com/
Gate.io	Cryptocurrency Exchange	https://www.gate.io/
Gatehub	Payment Gateways	https://gatehub.net/
GBI	Bullion store	https://www.bullioninternational.com/
GCBIB	Crypto Bank	https://www.gcbib.com/
Gemini	Cryptocurrency Exchange	https://www.gemini.com/
General Bytes	ATMs	https://www.generalbytes.com/en/
Genesis	Broker	https://genesistrading.com/
Genoa Institute	Online education website	https://genoainstitute.com/
Giacobbe & Co.	Jewelery	https://giacobbeandco.com/
Gigabet	Casino/Online Betting	https://www.gigabet.com/
Ginco	Payment Gateways	https://ginco.io/en/
Glace Bay Luxury Shuttle	Rental car company	https://hankcooper.com/shuttle
Globee	Payment Gateways	https://globee.com/
Gobbill	Payment Gateways	https://www.cointree.com/trade/pay-bills-with-cryptocurrency
Godex	Cryptocurrency Exchange	https://godex.io/
GogoCoins	Cryptocurrency Exchange	https://trade.gogocoins.io/
Gokumarket	Cryptocurrency Exchange	https://gokumarket.com/
GoLance (ODL)	Online Workforce Platform	https://golance.com/
GoPAx	Cryptocurrency Exchange	https://www.gopax.com/
Greitai	Travel booking site	https://www.greitai.lt/
Grupo Laguna	Real Estate investment group	http://orchidgarden.website/grupo-laguna.html
Grupo Terramovil del Mediterraneo SL	Car dealer	https://criptocoches.com/
GSR	Financial services	https://www.gsr.io/
Guarda	Payment Gateways	https://guarda.com/
Hacker Noon	Publication	https://hackernoon.com/
Hanbitco	Cryptocurrency Exchange	https://hanbitco.com/
Harbor	Wallet	https://harbor.com/
Hard Protocol/Kava Labs	Lending	https://www.kava.io/
Harmonie im Garten	Garden goods	https://www.harmonie-im-garten.at/
Hauer 1a	Contractor	https://www.hauer1a.at/
Haus Irene	Accomodations	https://www.ferienwohnungen-irene.de/
hbus	Cryptocurrency Exchange	https://www.huobi.us/
Helio Lending	Crypto Backed Loans	https://heliolending.io/
Henley Audtio	A/V services for events	https://henleyaudio.com/
Hide.me	VPN	https://hide.me/en/
Hitbtc	Cryptocurrency Exchange	https://hitbtc.com/
Hodl Boutique	Purchase/Fashion Apparel	https://hodl.boutique/
Hodl Finance	Crypto Backed Loans	https://hodlfinance.io/
Hoo	Cryptocurrency Exchange	https://hoo.com/
HostBlock	Web Hosting Provider	https://www.hostblock.io/
Hostería Encantó del Lolog	Accomodations	https://encantodellolog.com/
Hostiso	Hosting Provider	https://hostiso.com/
Hostsailer	Technology	https://hostsailor.com/how-to-pay-with-cryptocurrencies/
Hostwinds	Web Hosting Provider	https://www.hostwinds.com/
Hotel Ploberger	Accomodations	https://www.hotel-ploberger.at/de/
Hotel Vienna	Accomodations	https://www.hotelvienna.at/

Hubert Staudinger	Electronic services	http://www.elektro-staudinger.com/
HubrisOne	Wallet/Payments	https://www.hubrisone.com/
Huobi	Cryptocurrency Exchange	https://www.huobi.com/en-us/
Ice3x	Cryptocurrency Exchange	https://ice3x.co.za
IDT (ODL)	Money Transfer	https://www.idt.net/
imove	Wallet	https://imove.io/index
InCore Bank AG	Custody, Trading	https://www.sobaco-incore.com/en/sobaco-group/incore-bank-ltd
Independent Reserve	Payment Gateways	https://www.independentreserve.com/
IndoDax	Cryptocurrency Exchange	https://indodax.com/en/
Indybudmarv2	3D printing and design	https://www.budmarv2.com/
InkaPay	Payment Gateways	https://www.inkapay.com/inka/home
instantbitex	Cryptocurrency Exchange	http://instantbitex.com/
Instimatch	Interbank Trading	https://www.instimatch.ch/
Interbank (ODL)	Bank	https://interbank.pe/
Intergiro (ODL)	Money Transfer	https://intergiro.com/
Intermex (ODL)	Money Transfer	https://corporate.intermexonline.com/en/
itbit	Cryptocurrency Exchange	https://www.paxos.com/itbit/
itlawyers.gr LLC	Legal services	https://www.itlawyers.gr/
JNFX (ODL)	Money Transfer	https://jn-fx.com/
Jubi	Cryptocurrency Exchange	https://www.jbex.com/
KAZARTT	Purchase/Fashion Apparel	https://www.kazartt.com/
Keep SECZ	Private Etherium container	https://keep.network/
KeepKey	Hardware wallet	https://shapeshift.com/keepkey
Keyless Technologies	Authentication software	https://keyless.io/
Keys4coins	Marketplace	https://www.keys4coins.com/
KinkyBoots & Bits	Purchase/Fashion Apparel	https://www.kinkyboots.com.au/
Kiss Shoes	Purchase/Fashion Apparel	https://www.kisshoes.ch/en/
Koinex	Cryptocurrency Exchange	https://koinex.in/
Korbit	Cryptocurrency Exchange	https://www.korbit.co.kr/
Kraken	Cryptocurrency Exchange	https://www.kraken.com/en-us/
Kreuzerhof	Unclear; family farm?	https://www.kreuzerhof.at/
Kristina Rybaltchenko	Purchase/Fashion Apparel	https://rybaltchenko.com/
Kryptohotel Vienna	Accomodations	https://www.kryptohotel.at/
kryptono	Cryptocurrency Exchange	https://kryptono.exchange/
Kun Koro	Counseling	https://kunkoro.kiwi/indexeng.html#
Kuna.io	Cryptocurrency Exchange	https://kuna.io/
Laferla	Insurance company	https://www.laferla.com.mt/
Lakebtc	Cryptocurrency Exchange	https://www.lakebtc.com/
LATOKEN	Cryptocurrency Exchange	https://latoken.com/
LavaVPS	VPN Hosting	https://www.lavavps.lt/en/
lbank	Cryptocurrency Exchange	https://www.lbank.info/
Ledger	Payment Gateways	https://www.ledger.com/
LidiaPay	Software	https://lidiapay.com/
LiteBit	Cryptocurrency Exchange	https://www.litebit.eu/en
Living Room of Satoshi	Payment Gateways	https://www.livingroomofsatoshi.com/
London Block Exchange (LBX)	Cryptocurrency Exchange	http://www.lbx.com/
Lord	Purchase/Fashion Apparel	https://www.lord.gr/en/
Luckbox	E-sports betting	https://luckbox.com/
Luckyfish	Casino/Online Betting	https://luckyfish.io/
Luckygames	Casino/Online Betting	https://luckygames.io/
Luno	Cryptocurrency Exchange	https://www.luno.com/en/
Mader Reisen	Travel agency	https://www.maderreisen.at/Home/
Maerki Baumann & Co. AG	Custody, Trading	https://www.maerki-baumann.ch/en
Maicoin	Cryptocurrency Exchange	https://www.maicoin.com/
Marketing Empire	Digital Marketing Agency	https://marketingempire.co.uk/
MBAex	Cryptocurrency Exchange	https://www.mbaex.com/#/index
Mental Market	Marketplace	http://mentalmarketing.com/
Mercadobitcoin	Cryptocurrency Exchange	https://www.mercadobitcoin.com.br/
MercuryFX (ODL)	Money Transfer	https://www.mercury-fx.com/
Metal Pay	Payments	https://www.metalpay.com/
Mileata	Watch manufacturer	https://mileata.com/
MinedTrade	Cryptocurrency Exchange	https://minedtrade.com/en/
Mixort	Tech	https://mixort.com/

MMOGA	Gaming	https://www.mmoga.com/
Mobi	Payments/Wallet	https://www.mobiapp.cn/
Moneygram (ODL)	Money Transfer	http://global.moneygram.com/
MoneyMatch	International Money Transfers	https://transfer.moneymatch.co/
MoneyMessage	Extension/AddIn	http://moneymessage.radynamics.com/moneymessage_www/?
MoneyTap	International Money Transfers	https://moneytap.jp/
Moneytoken	Lending	https://moneytoken.eu/
Mopesa Car Rental	Rental car service	https://www.facebook.com/mopesacarrentalkoronadal/
Morph	Wallet	https://morphwallet.com/
Mr-Ripple	Cryptocurrency Exchange	https://ee.mr.exchange/
Mudrex	Cryptocurrency Exchange	https://mudrex.com/
Multichange	Cryptocurrency Exchange	https://multichange.net/en
MVIS and ITI Fund	Crypto Fund	https://www.mvis-indices.com/indices/digital-assets/mvis-cryptocompare-digital-assets-10
MXC	Cryptocurrency Exchange	https://www.mxc.com/auth/signup?inviteCode=15ZDa
MyCryptoCard	Card/Wallet	https://mycryptowallet.com.au/
MyCryptoCheckout	Payment Gateways	https://mycryptocheckout.com/
Nebeus	Wallet	https://nebeus.com/
Net Cents	Payment Gateways	https://net-cents.com/
Neteller	E-money transfer service	https://www.neteller.com/en
Nexo	Lending	https://nexo.io/
NiceChange	Cryptocurrency Exchange	https://nicechange.net/en
Nium (ODL) Former Instarem	Money Transfer	https://www.nium.com/
No Middle Man Crypto	Payment Gateways	https://nomiddlemancrypto.io/
NordVPN	Technology	https://nordvpn.com/
Now Payments	Payment Gateways	https://nowpayments.io/
NYDIG	Custody	https://nydig.com/
Oanda	Cryptocurrency Exchange	https://www.oanda.com/us-en/
ObmenMoney	Cryptocurrency Exchange	https://obmen.money/
OceanEx	Cryptocurrency Exchange	https://oceanex.pro/m/
Oex.com	Cryptocurrency Exchange	https://oex.com/#/
OffshoreDedicated	Hosting Provider	https://offshorededicated.net/
Okcoin	Cryptocurrency Exchange	https://www.okcoin.com/en
Okex	Cryptocurrency Exchange	https://www.okex.com/
Omgserv	Minecraft Server	https://www.omgserv.com/en/
Omni Projects	Software	omnigroup.com
Opu Labs	Healthcare e-commerce	https://www.opulabs.com/
Orionx	Cryptocurrency Exchange	https://www.orionx.com/en/
OS Limited	Cryptocurrency brokerage/exchange	https://osl.com/en/
Otcbtc	Cryptocurrency Exchange	https://otcbtc.com/
Oveit	Event/venue payments	https://oveit.com/
Paid By Coins	Bill Payments	https://paidbycoins.com/
Paritex	Cryptocurrency Exchange	https://www.paritex.com/
Paybis	Card	https://paybis.com/
Payburner	Payment Gateways	https://www.payburner.com/
PayC	Payments	http://www.payc.io/
Paycent	Payment platform	https://paycent.com/
PAYCRYPTO	Payment Gateways	https://paycrypto.co.kr/
Payeer	Payment Gateways	https://payeer.com/
PayGlobal	Money Transfer	https://payglobal.me/
PayKassa	Payment Gateways	https://paykassa.pro/en/
Payza	Cryptocurrency Exchange	https://www.payza.org/
PexPeppers	Marketplace	https://pexpeppers.com/
PlasmaPay	Payments	https://plasmapay.com/
Plus500	Cryptocurrency Exchange	https://www.plus500.com/
Pocket Network	Cryptocurrency Exchange	https://www.pokt.network/
Poloniex	Cryptocurrency Exchange	https://poloniex.com/
Polysign	Custody	https://www.polysign.io/
PPC Protect	Fraud Prevention	https://ppcprotect.com/
PrestigeTime	Online luxury watch store	https://www.prestigetime.com/

Primedice	Casino/Online Betting	https://primedice.com/
Print Ted	Purchase/Fashion Apparel	https://print-ted.com/
ProBit	Cryptocurrency Exchange	https://www.probit.com/en-us/
Propy	Marketplace	https://propy.com/browse/
Prostocash	Cryptocurrency Exchange	https://prostocash.com/
Puma Technologies	Browser	https://www.pumabrowser.com/
PumaPay	Payments	https://pumapay.io/
Qeeq	Rental car service	https://www.qeeq.com/
Qryptos (Liquid)	Cryptocurrency Exchange	https://www.liquid.com/
Quadrigacx	Cryptocurrency Exchange	https://quadrigacx.com
Quantoz (Nexus)	Transaction processing	https://quantoz.com/solutions/cryptocurrency-services/
Quoine	Cryptocurrency exchange [redirects to liquid.com]	https://www.quoine.com/?lang=en [redirects to liquid.com]
Quoinex	Cryptocurrency exchange	https://quoine.zendesk.com/hc/en-us
R3	Software	https://www.r3.com/
Raised In Space	Investment	https://raisedinspace.com/
RealSologenic	Cryptocurrency Exchange	https://www.sologenic.com/
Rebit	Cryptocurrency Exchange	https://rebit.org.in/
Refundo	Tax refund	https://refundo.com/
Revolut	Payment Gateways	https://www.revolut.com/en-US
RightBTC	Cryptocurrency Exchange	https://rightbtc.com/
Rights	Digital Market	https://rights-dapp.io/
Ripio	Cryptocurrency Exchange	https://www.ripio.com/ar/
RippleFox	Cryptocurrency Exchange	https://ripplefox.com/
Robot Ventures	Investor	https://robvc.com/
Royal.Cash	Cryptocurrency Exchange	https://royal.cash/en
SADAD (ODL)	Money Transfer	https://www.sadad.com/en/pages/home.aspx
SafePal	Wallet	https://www.safepal.io/
Salamantex	Payment Gateways	https://www.salamantex.com/en/
Salt Lending	Lending	https://saltlending.com/
Satang Pro	Crypto backed loans	https://satang.pro/
SatoWallet	Multi-accet exchange/wallet	https://www.satowallet.com/app/
SBI Ven Capital	Private Equity Firm	https://www.sbivencapital.com.sg/
sbivc	Cryptocurrency Exchange	https://sbivc.jp/#/login
sci.ph	Cryptocurrency Exchange	https://sci.ph/
Search Candy	Digital Marketing	https://www.searchcandy.uk/
Secalot	Wallet	https://www.secalot.com/
Secure Trading Group	Payments	https://www.trustpayments.com/
Securitize, Inc.	Financial services	https://www.securitize.io/
Selly	E-Commerce	https://selly.io/
SendFriend (ODL)	Money Transfer	https://www.sendfriend.io/
Sesocio	Investment platform	https://sesocio.com.ar/
SFOX	Cryptocurrency Exchange	https://www.sfox.com/
Shapeshift	Cryptocurrency Exchange	https://shapeshift.com/
Shopify	Marketplace	https://www.shopify.com/
Silicon Valley community foundation	Nonprofit advisor	https://www.siliconvalleycf.org/
simex	Cryptocurrency Exchange	https://simex.global/en
SimpleSwap	Cryptocurrency Exchange	https://simpleswap.io/
Sistemkoin	Cryptocurrency Exchange	https://sistemkoin.com/
Skrill	Online Payments/Money Transfer	https://www.skrill.com/en/
Snapswap	Financial services	https://www.snapswap.eu/
Snel.com	Technology	https://www.snel.com/
Sologenic	Tokenization	https://www.sologenic.com/
Sony CSL	Wallet	https://www.sonycsl.co.jp/
Sotados	Financial services	https://www.sotados.com/
Soulful Essence	Marketplace	https://soulfulessence.com/
Spend	Wallet/Card	https://www.spend.com/
SpendAcoin	Marketplace	https://spendacoin.com/
SportsBetting.ag	Casino/Online Betting	https://www.sportsbetting.ag/
SpotOn	Payment Processing Services	https://www.spoton.com/

SSL Dragon	SSL Certificate Marketplace	https://www.ssldragon.com/
Stake	Casino/Online Betting	https://stake.com/
Standing Ovation	Event Service Provider	https://standingovation.ch/en/
Stark Payments	Payments	https://starkpayments.com/
Starting Point Mental Health	Therapy	https://www.therapydelandfl.com/
Stats Autos Spa	Auto detailing	https://stats-auto-spa.com/
Staxe	Tokenization	https://staxe.io/
Stellarport	Cryptocurrency Exchange	https://stellarport.io/
Stellarterm	Cryptocurrency exchange	https://stellarterm.com/
Stone Ridge	Asset management	stoneridgeam.com
Stratum	Payment Gateways	https://stratum.bt/home
STYRA Technologies	Interledger gateway provider	https://www.styra.com/
SubscribeStar	Crowdfunding	https://www.subscribestar.com/
Sugi	Payment Gateways	https://sugi.io/pages/wallets
Suisse Gold	Precious metals Marketplace	https://www.suissegold.eu/en/
Swapcoins	Cryptocurrency Exchange	https://www.swapcoins.com/
Swipe	Wallet	https://www.swipe.io/
Swiss Crypto Vault	Crypto storage	https://swisscryptovault.ch/
Swissquote	Cryptocurrency Exchange	https://en.swissquote.com/crypto-assets/products/cryptocurrencies
Switchere	Cryptocurrency Exchange	https://switchere.com/
Sygnum Bank	Custody, Trading	https://www.sygnum.com/
Talizi Hair Transplantation Clinic	Hair transplants	https://tsilosani.com/en/
TapJets	Travel	https://www.tapjets.com/
techbureau	Cryptocurrency Exchange	https://techbureau.jp/
Tegiwa	Imports	https://www.tegiwaimports.com/
Ternio	Crypto Card	https://ternio.io/
Therocktrading	Cryptocurrency Exchange	https://www.therocktrading.com/en/
ti&m	IT service provider	https://www.ti8m.com/
TMD STUDIO LTD.	Architecture	https://www.tmd.studio/
Toast Wallet	Payment Gateways	https://toastwallet.com/
Toca Coffee	Marketplace	https://www.tocacoffee.com/
TokenAd	Advertising	https://token.ad/
TokenKart	Cryptocurrency Exchange	https://www.tokenkart.com/
TOKOK	Cryptocurrency Exchange	https://www.tokok.com/
topbtc	Cryptocurrency Exchange	https://www.topbtc.com/
TorGuard	Technology	https://torguard.net
Tower.bet	Casino/Online Betting	https://tower.bet/
Towo Labs AB (formerly xrptoolkit)	Custody	https://www.towolabs.com/
Tra Mente e Corpo	Beauty saloon	https://www.tramenteecorpo.com/
Trachtenhans	Purchase/Fashion Apparel	https://www.trachtenhans.com/
Trade Satoshi	Cryptocurrency Exchange	http://tradesatoshi.com/
Transfer4cheap	Travel	https://www.transfer4cheap.com/en
TransferGo (ODL)	International Money Transfers	https://www.transfergo.com/en-gb
Transpaygo (ODL)	Money Transfer	https://transpaygo.com/
Trastra	Payment Gateways	https://wallet.trastra.com/
Travala	Purchase/Travel	https://www.travala.com/payment/xrp
Travolier Hoteliermart	Loyalty program	https://travolier.com/
Trezor	Payment Gateways	https://trezor.io/
Trip.io	Travel booking site	www.trip.io* Website not operational
Trippki	Purchase/Travel	https://trippki.com/
Triv Pro	Cryptocurrency Exchange	https://tpro.co.id/
Tron Network Store	Merchandise store	https://tronnetwork.store/
Trust Payments	Payment platform	https://www.trustpayments.com/
Trust Wallet	Payment Gateways	https://trustwallet.com/
TruViewz	Photographer	https://truviewz.com/
Two Rivers	Investment management firm	http://2rcc.com/
uConektPAY	Payments processor	https://uconekt-pay.com/
Uex.com	Cryptocurrency Exchange	http://uex.com/
Ultimez	Web Design	https://ultimez.com/
Unicef	Charity	https://www.unicef.fr/
Unocoin	Cryptocurrency exchange	https://www.unocoin.com/in
Upbit	Cryptocurrency exchange	https://sg.upbit.com/home
Uphold	Cryptocurrency Exchange	https://uphold.com/en-us/

Upvotes Club	Marketplace	https://upvotes.club/
Varle.lt	Online marketplace	https://www.varle.lt/
VeePN	VPN	https://veepn.com/
Vega Protocol	Financial services software	https://vega.xyz/
Velic	Cryptocurrency exchange	https://www.velic.io/
Velocity Markets Inc	Marketplace	https://www.velocitymkts.com/
Venus	Lending	https://venus.io/
ViaBTC	Cryptocurrency mining service	https://www.viabtc.com/
Viamericas (ODL)	Money Transfer	https://corporate.viamericas.com/
Victory Rentals	Outdoor equipment rental	https://www.victory-rentals.com/
Villa Eros Apartments	Accomodations	https://villa-eros.weebly.com/
VinDAX	Cryptocurrency exchange	https://vindax.com/forbidden.html
Volkskraftwerk	Energy technology	https://www.volkskraftwerk.com/
Vontobel Investment Banking	Wealth management, active asset management and investment solutions	https://www.vontobel.com/en-int/
W.Hamond	Jewelry Store	https://whamond.com/
WazirX	Cryptocurrency exchange	https://wazirx.com/
WeCashUp	Payments	https://www.wecashup.com/
WeMakePrice	Mall	https://front.wemakeprice.com/main
WestWallet	Payment Gateways	https://westwallet.io/
Win Dice	Casino/Online Betting	https://windice.io/
Winipple	Purchase/Fashion Apparel	https://winipple.com/shop/
Wirex	Payment Gateways	https://wirexapp.com/
WOLF.BET	Casino/Online Betting	https://wolf.bet/
WooCommerce	E-commerce hosting	https://woocommerce.com/
Worldcore	Online Payment Service Provider	https://worldcore.com/
Wrecky Car Wreckers	Towing service	https://www.wrecky.com.au/
Xago	Payment Gateways	https://xago.io/
XcelTrip	Travel booking site	https://www.xceltrip.com/
xChange.me	Cryptocurrency Exchange	https://xchange.me/
xCryptoCrash	Gambling site	https://xcryptocrash.com/
Xeeda	Wallet	https://xeeda.io/
XRP Charities Metrics Page	Charitable Giving	goodxrp.org
XRP Text	Money Transfer	https://sms.xrptext.com/
XRPL Labs	Development	https://xrpl-labs.com/
XRPTipBot	Social Tipping App	https://www.xrptipbot.com/
xtb.com	Cryptocurrency Exchange	https://www.xtb.com/int
xtremcoin	Cryptocurrency Exchange	https://www.xtremcoin.com/
Xumm Wallet	Payment Gateways	https://xumm.app/
Yacht Break	Yacht Charter	https://theyachtbreak.com/
YChanger	Cryptocurrency Exchange	https://ychanger.net/
Yobit	Cryptocurrency Exchange	https://yobit.net/en/
YouHodler	Lending	https://www.youhodler.com/
Young Platform	Cryptocurrency Exchange	https://youngplatform.com/
YunEx	Cryptocurrency Exchange	https://yunex.io/
ZB	Cryptocurrency Exchange	https://zb.com
ZBG	Cryptocurrency Exchange	https://www.zbg.com/
ZebPay	Cryptocurrency Exchange	https://zebpay.com/
Zwei Fach Vertriebs GmbH	Interior decorating	https://www.zwei-fach.at/

Use Cases with Inactive Websites		
Entity Name	**Category**	**Website**
CODEX	Cryptocurrency exchange [domain expired]	https://codex.one/
Coinbe	Cryptocurrency exchange [website down]	http://ww12.coinbe.net/
Coincenter	Collectible trading site [website down]	https://www.coincenter.org/
CoinExmarket	Cryptocurrency Exchange [website down]	http://coinexmarket.io/
coinhub	Cryptocurrency exchange [website down]	https://coinhub.io
Coinlim	Cryptocurrency exchange [website down]	https://www.coinlim.com/
CoinMex	Cryptocurrency exchange [website down]	www.coinmex.com
Coinsecure	Cryptocurrency exchange [website down due to cyberattack]	https://coinsecure.in/
Cointal	Cryptocurrency exchange [website down]	http://www.cointal.com/
Coinverso	Cryptocurrency exchange [website down]	https://coinverso.com
Cryptohub	Cryptocurrency giveaway site [website down]	https://cryptohub.online/
Darb Finance	Cryptocurrency exchange [website down]	https://darbfinance.com
digitalassetcustody (DACC)	Cryptocurrency custodian [website down]	https://digitalassetcustody.com/
dragonex	Cryptocurrency exchange [website down]	https://dragonex.io/en-us/
Fcoin	Cryptocurrency exchange [website down]	www.fcoin.com
Mydicewallet	Cryptocurrency exchange [website down]	https://www.mydicewallet.com/
Octagon Strategy	Financial services [website down]	https://www.octfinancial.com/
ooobtc	Cryptocurrency exchange [website down]	https://www.ooobtc.com/
Vebitcoin	Cryptocurrency exchange [website down]	https://www.vebitcoin.com/
WorldWideMarketsOnline	Cryptocurrency exchange [website down]	http://worldwidemarkets.com/
Xbtce	Cryptocurrency exchange [website down]	https://www.xbtce.com/
XRP Fund	Unknown	No Website
Zamisa IT Solutions	IT service provider [website down]	http://zamisaitsolutions.co.za/

Appendix D - List of Third Party Use Cases

List of Third Party Use Cases Receiving Venture Capital and Founded after Ripple's Founding

uConektPAY	Payments processor	https://uconekt-pay.com/	0.011	2015
Cryptonator	Payment Gateways	https://www.cryptonator.com/	0.02	2014
Qryptos (Liquid)	Cryptocurrency Exchange	https://www.liquid.com/	0.05	2013
Harbor	Wallet	https://harbor.com/	0.1	2017
Fliqpay	Payment Gateway	https://www.fliqpay.com/	0.12	2019
Stark Payments	Payments	https://starkpayments.com/	0.12	2018
Cryptosa	Advisory Firm	https://cryptosa.org/	0.17	2018
Crumbs App	App	https://www.crumbsapp.com/	0.175	2017
Staxe	Tokenization	https://staxe.io/	0.234	2018
TapJets	Travel	https://www.tapjets.com/	0.4	2015
Bpay	Payments	https://bpay.com.au/	0.5	2017
Oveit	Event/venue payments	https://oveit.com/	0.6	2016
MoneyMatch	International Money Transfers	https://transfer.moneymatch.co/	0.6	2015
Pocket Network	Cryptocurrency Exchange	https://www.pokt.network/	0.75	2017
CoinPayments	Payment Gateways	https://www.coinpayments.net/	1	2013
Trastra	Payment Gateways	https://wallet.trastra.com/	1	2017
ZebPay	Cryptocurrency Exchange	https://zebpay.com/	1.1	2014
Edge	Payment Gateways	https://edge.app/	1.2	2014
HubrisOne	Wallet/Payments	https://www.hubrisone.com/	1.4	2017
Ellipal	Wallet	https://www.ellipal.com/	1.5	2016
Luckyfish	Casino/Online Betting	https://luckyfish.io/	1.6	2012
PlasmaPay	Payments	https://plasmapay.com/	1.6	2017
SendFriend (ODL)	Money Transfer	https://www.sendfriend.io/	1.7	2017
Travala	Purchase/Travel	https://www.travala.com/payment/xrp	2	2017
PPC Protect	Fraud Prevention	https://ppcprotect.com/	2.9	2016
CoinLoan	Lending	https://coinloan.io/earn-interest/	3.1	2017
Action Factory Inc. (d/b/a Stronghold)	Payment Gateways	https://stronghold.co/	3.3	2017

Luckbox	E-sports betting	https://luckbox.com/	3.8	2016
Agoric Systems LLC	Smart Contracts	https://agoric.com/	4	2018
BCB Group	Broker and Custodian	https://bcbgroup.io/	4.5	2017
Worldcore	Online Payment Service Provider	https://worldcore.com/	5	2014
Viamericas (ODL)	Money Transfer	https://corporate.viamericas.com/	6	1999
Young Platform	Cryptocurrency Exchange	https://youngplatform.com/	6.1	2018
Unocoin	Cryptocurrency exchange	https://www.unocoin.com/in	7	2013
Wirex	Payment Gateways	https://wirexapp.com/	7.9	2014
Keyless Technologies	Authentication software	https://keyless.io/	9.5	2019
Luckygames	Casino/Online Betting	https://luckygames.io/	10	2013
Okcoin	Cryptocurrency Exchange	https://www.okcoin.com/en	10	2013
Vega Protocol	Financial services software	https://vega.xyz/	10	2018
Coins.ph	Payment Gateways	https://coins.ph/	10	2014
Sesocio	Investment platform	https://sesocio.com.ar/	11.4	2017
Bitstamp	ODL Exchange	https://www.bitstamp.net/	12.4	2011
BitBounce	Paid email service	https://bitbounce.com/	12.5	2014
Shapeshift	Cryptocurrency Exchange	https://shapeshift.com/	12.8	2014
ZB	Cryptocurrency Exchange	https://zb.com	13	2004
Coinify	Payment Gateways	https://www.coinify.com/	13.1	2014
Uphold	Cryptocurrency Exchange	https://uphold.com/en-us/	15.5	2014
Trip.io	Travel booking site	www.trip.io* Website not operational	16	2015
Propy	Marketplace	https://propy.com/browse/	16.7	2016
Cryptopay	Wallet/Card	https://cryptopay.me/	18.1	2013
CoinMe	Financial Services	https://coinme.com/	19.1	2014
Cobo	Payment Gateways	https://cobo.com/	20	2017
Bitgild	Precious metals Marketplace	https://www.bitgild.com/	20	2017
techbureau	Cryptocurrency Exchange	https://techbureau.jp/	21.7	2014
Bluzelle	Technology	https://bluzelle.com/	22.3	2014
SFOX	Cryptocurrency Exchange	https://www.sfox.com/	23.1	2014
Crypto.com	Payment Gateways	https://crypto.com/en/pay.html	26.7	2016

ViaBTC	Cryptocurrency mining service	https://www.viabtc.com/	32.9	2016
Blockdaemon	Networking	https://blockdaemon.com/	39.6	2017
Otcbtc	Cryptocurrency Exchange	https://otcbtc.com/	40	2017
MoneyTap	International Money Transfers	https://moneytap.jp/	40.3	2015
Ripio	Cryptocurrency Exchange	https://www.ripio.com/ar/	44.4	2013
Ecwid	E-commerce hosting	https://www.ecwid.com/	48.5	2009
AavePay	Bill Payments	https://aave.com/	49	2017
Bitcoin Suisse	Institutional-grade storage and exchange	https://www.bitcoinsuisse.com/	49	2013
Flare Finance / Flare Networks	Smart Contracts	https://flare.xyz/	50	2015
STYRA Technologies	Interledger gateway provider	https://www.styra.com/	54	2016
BRD	Wallet	https://brd.com/	54.8	2015
Exodus	Wallet	https://www.exodus.com/	60	2015
BitGo	Payment Gateways	https://www.bitgo.com/	69.5	2013
TransferGo (ODL)	International Money Transfers	https://www.transfergo.com/en-gb	69.7	2012
BitPay	Payment Gateways	https://bitpay.com/	72.5	2011
Polysign	Custody	https://www.polysign.io/	74.7	2018
Securitize, Inc.	Financial services	https://www.securitize.io/	87.5	2017
Azimo (ODL)	Money Transfer	https://azimo.com/	88.1	2012
Celsius Network	Lending	https://celsius.network/	93.8	2017
R3	Software	https://www.r3.com/	112	2014
PumaPay	Payments	https://pumapay.io/	117	2017
Shopify	Marketplace	https://www.shopify.com/	122.3	2004
Quoine	Cryptocurrency exchange [redirects to liquid.com]	https://www.quoine.com/?lang=en [redirects to liquid.com]	132.6	2013
Anchorage	Custody	https://www.anchorage.com/	137	2017
Plus500	Cryptocurrency Exchange	https://www.plus500.com/	152	2008
Coil	Micropayments/Tips	https://coil.com/about	269	2018
CoinCorner	Payment Gateways	https://www.coincorner.com/	300	2014
SpotOn	Payment Processing Services	https://www.spoton.com/	315	2017
Chainalysis	Blockchain Analysis	https://www.chainalysis.com/	366.6	2014

Bitso	ODL Exchange	https://bitso.com/	378.4	2014
NYDIG	Custody	https://nydig.com/	405	2017
Ledger	Payment Gateways	https://www.ledger.com/	468	2014
WeMakePrice	Mall	https://front.wemakeprice.com/main	476	2010
Revolut	Payment Gateways	https://www.revolut.com/en-US	905.5	2014

Appendix E

Brief Timeline of Ripple Products, Fundraising Rounds, and Accolades

- **May 2013 – Open Coin raises angel funding from a variety of investors, including Google Ventures, IDG Capital Partners, Andreessen Horowitz, FF Angel IV, Lightspeed Venture Partners, Vast Ventures and the Bitcoin Opportunity Fund.**

  Source: https://www.coindesk.com/google-ventures-invests-in-bitcoin-competitor-opencoin

- **Oct. 8, 2013 – Ripple announces an agreement with cash-transaction network ZipZap Inc. to expand distribution of XRP and money-transfer software. It also announces that ZipZap and SnapSwap have created a cash-in, cash-out network on Ripple through which users can fund their Ripple Wallets in-person or online, with or without a bank account.**

  Source: https://www.coindesk.com/ripple-labs-now-taking-cash-payments-zipzap-snapswap

- **Nov. 12, 2013 – Ripple Labs raises $3.5 Million in seed funding round. Investors included Core Innovation Capital, Venture 51, Camp One Ventures, IDG Capital Partners, and a small set of unnamed individuals.**

  Source: https://ripple.com/insights/ripple-labs-raises-3-5-million-in-new-investment-round/

- **Jan. 31, 2014 - Ripple announces that Singapore service Bullion Exchange uses Ripple network to acquire, store and convert precious metals into any currency for customers anywhere in the world.**

  Source: https://www.coindesk.com/bullion-exchange-brings-ripple-physical-world

- **Feb. 10, 2014 – Ripple announces update to "RippleCharts," which provides live data feeds regarding Ripple Network analytics to make "Ripple network data more accessible and easier to digest."**

  Source: https://ripple.com/insights/ripplecharts-revamp/.

- **Feb. 18, 2014 – Ripple Labs is included on MIT Technology Review's 2014 "50 Smartest Companies" List**

  Source: https://ripple.com/insights/ripple-labs-makes-mit-technology-reviews-2014-50-smartest-companies-list/

- **Feb. 19, 2014 – Ripple Labs Named a Finalist for a PYMNTS 2014 Innovator Award for Ripple Payments Protocol**

  Source: https://www.businesswire.com/news/home/20140219006020/en/Ripple-Labs-Named-a-Finalist-for-a-PYMNTS-2014-Innovator-Award-for-Ripple-Payments-Protocol

- **May 4, 2014 – German Internet direct bank Fidor becomes the first bank to integrate Ripple's payment protocol into its transaction infrastructure, allowing its customers to instantly send money in any currency in any amount through the bank's money transfer products at a lower cost.**

  Source: https://www.coindesk.com/fidor-becomes-first-bank-to-use-ripple-payment-protocol

- **May 12, 2014 – Bitso launches Ripple gateway for the peso to allow remittance capabilities to its customers.**

  Source: https://www.coindesk.com/ripple-network-expands-addition-first-peso-issuer

- **June 12, 2014 – Licensed money services business AstroPay (a payment services provider for companies like Facebook and Disney in Latin America) launches "Ripple LatAm," connecting seven countries in Latin American market with the digital currency payment provider Ripple Labs' network partners and gateways in North America, Europe and Asia.**

  Source: https://www.paymentssource.com/news/astropay-to-use-ripple-for-digital-payments-in-latin-america

- **July 7, 2014 – Ripple launches "Ripple Trade," the rebranded version of the Ripple Client.**

  Source: https://ripple.com/insights/introducing-the-new-ripple-trade-client/

- **Aug. 13, 2014 – SnapSwap, which operates Ripple gateways in the US and Europe, launches SmartyCash, a prepaid card powered by Ripple that is available through SnapSwap.eu that offers a 5 percent rebate on purchases, paid in XRP.**

  Source: https://ripple.com/insights/a-debit-card-powered-by-ripple/

- **Sept. 24, 2014 – Ripple announces the first two U.S. banks to use Ripple network for real-time, cross-border payments: Cross River Bank and CBW Bank.**

  Source: https://ripple.com/insights/ripple-labs-signs-first-two-us-banks/

- **Dec. 3, 2014 – Ripple announces partnership with Earthport, a regulated financial institution whose cross-border platform represents the largest open network for global bank payments.**

  Source: https://ripple.com/insights/ripple-labs-earthport-announce-global-partnership/

- **Feb. 9, 2015 – Ripple Labs Makes Fast Company's 2015 Most Innovative Companies List "for building a global rail system on the Internet to instantly transfer value without a middleman."**

Source: https://ripple.com/insights/ripple-labs-makes-fast-companys-2015-most-innovative-company-list/

- **May 8, 2015 – Ripple closes $28 million Series A funding round (which would ultimately grow to $32 million). Investors included IDG Capital Partners, the venture arms of CME Group, and the global data storage company Seagate Technology. Other new investors include Jerry Yang's AME Cloud Ventures, ChinaRock Capital Management, China Growth Capital, and Wicklow Capital.**

  Source: https://ripple.com/ripple_press/ripple-labs-closes-28-million-series-a-funding-round/

- **Aug. 5, 2015 – Ripple Labs Awarded as Technology Pioneer by World Economic Forum. The committee based its decisions on "criteria including innovation, potential impact, working prototype, viability and leadership."**

  Source: https://ripple.com/ripple_press/ripple-labs-awarded-as-technology-pioneer-by-world-economic-forum/

- **Oct. 6, 2015 – Ripple offers two solutions for license – Cross-Currency Settlement and FX Market Making – with features and support that help banks meet rising customer and regulatory demand for faster, less costly payments. Ripple also announces that Santander InnoVentures had joined Ripple's Series A funding round as a strategic investor.**

  Source: https://ripple.com/ripple_press/new-ripple-settlement-and-fx-solutions-lower-the-total-cost-of-settlement-for-banks-and-their-customers/

- **Oct. 6, 2015 – Ripple announces Interledger Protocol, a scalable, universal solution for payments across payment networks.**

  Source: https://ripple.com/insights/a-new-chapter-for-ripple/

- **Oct. 12, 2015 – Ripple is listed in the American Banker's "20 Fintech Companies to Watch."**

  Source: https://www.americanbanker.com/slideshow/20-fintech-companies-to-watch

- **Dec. 9, 2015 – Ripple is named to Forbes' inaugural edition of The Fintech 50**

  Source: https://www.forbes.com/sites/samanthasharf/2015/12/09/the-fintech-50-the-complete-list/?sh=65b6c9fe56a5

- **Jan. 28, 2016 -- Ripple announces deal with global financial services company SBI Holdings Inc. to create SBI Ripple Asia and build an engineering and sales force across Japan, China, Taiwan, Korea, and ASEAN countries to sell and install Ripple's enterprise solutions for cross-border payments at banks across Asia**

Source: https://ripple.com/ripple_press/ripple-strikes-multi-national-deal-with-sbi-holdings-to-meet-growing-demand-for-ripple-solutions-across-asia

- **May 26, 2016 – Santander announces they are the first U.K. bank to introduce Ripple's blockchain technology to facilitate international payments through a new app. They are rolling it out as a staff pilot, with the intention to expand the technology at a later date.**

  Source: https://ripple.com/insights/santander-becomes-first-uk-bank-use-ripple-cross-border-payments/

- **June 22, 2016 – Ripple announces the names of seven banks on its network: Santander, UBS, UniCredit, ReiseBank, CIBC, National Bank of Abu Dhabi (NBAD), and ATB Financial.**

  Source: https://ripple.com/insights/seven-leading-banks-join-ripples-global-network/

- **June 27, 2016 – Ripple is listed as one of Fortune's "5 Hottest Companies in Fintech."**

  Source: https://fortune.com/2016/06/27/five-hottest-fintechs/ [*Note: this article is behind a paywall and we can share a PDF if helpful.*]

- **Aug. 19, 2016 -- SBI Ripple Asia announces a consortium of 15 Japanese banks that will use Ripple's technology for a new payments platform.**

  Source: https://asia.nikkei.com/Business/Trends/Japan-banks-to-lay-groundwork-for-24-hour-fund-transfers?page=1

- **Sept. 15, 2016 – Ripple announces the addition of several more financial institutions to the network. Standard Chartered, National Australia Bank (NAB), Mizuho Financial Group (MHFG), BMO Financial Group, Siam Commercial Bank and Shanghai Huarui Bank are now among the global banks that have adopted Ripple's settlement technology to improve their cross-border payments and offer their customers improved service.**

  Source: https://ripple.com/insights/several-global-banks-join-ripples-growing-network/

- **Sept. 15, 2016 – Ripple raises $55MM in Series B funding, with participation from Standard Chartered, Accenture, and SBI Holdings.**

  Source: https://fortune.com/2016/09/15/ripple-raises-55m-adds-major-bank-partners-as-blockchain-gains-ground/

- **Oct. 20, 2016 – Ripple announces "Project "Xenon" results: 12 banks went through trials using XRP as a settlement tool.**

Source: https://ripple.com/insights/ripple-and-r3-team-up-with-12-banks-to-trial-xrp-for-cross-border-payments/

- **Nov. 7, 2016 – Ripple is named to the Forbes Fintech 50 For 2016**

  Source: https://www.forbes.com/sites/janetnovack/2016/11/07/the-forbes-fintech-50-for-2016/?sh=33aa4b3a1b10

- **Jun. 27, 2017 – Ripple named to CB Insights Fintech 250 List**

  Source: https://www.prnewswire.com/news-releases/cb-insights-reveals-the-fintech-250-list-at-future-of-fintech-300480303.html; https://www.bloomberg.com/press-releases/2017-06-29/cb-insights-reveals-the-fintech-250-list-at-future-of-fintech

- **July 31, 2017 – Ripple announces RippleNet product suite, including xCurrent, ILP, xRapid, and xVia. At that time, xCurrent was already in use by customers, but xRapid and xVia were still in development.**

  Source: https://ripple.com/insights/ripples-product-suite-growing/

- **Oct. 2017 – Ripple announces first xRapid pilot with Cuallix**

  Source: https://www.cnbc.com/2017/10/10/ripple-has-over-100-clients-as-mainstream-finance-warms-to-blockchain.html

- **Nov. 16, 2017 – American Express joins RippleNet. American Express FX International Payments (FXIP) will partner with Santander UK to create a transaction channel between the U.S. and U.K.**

  Source: https://ripple.com/insights/american-express-joins-ripplenet-giving-visibility-and-speed-to-global-commercial-payments/

- **Jan. 11, 2018 – Ripple announces MoneyGram to pilot xRapid.**

  Source: https://www.coindesk.com/moneygram-to-pilot-ripples-xrp-token-for-international-payments

- **Jan. 23, 2018 – In addition to Cuallix and MoneyGram, Ripple states IDT Corporation and MercuryFX are piloting xRapid.**

  Source: https://ripple.com/insights/much-ado-much-to-do-part-3/

- **Feb. 13, 2018 – Ripple named to the Forbes Fintech 50 list for 2018**

  Source: https://www.forbes.com/sites/laurashin/2018/02/13/forbes-fintech-50-2018-the-future-of-blockchain-and-crypto/?sh=546a7e8a1036

- **Feb. 14, 2018 – Western Union announces xRapid pilot.**

  Source: https://fortune.com/2018/02/14/ripple-xrp-western-union-money-transfers/; https://www.financemagnates.com/cryptocurrency/news/rumors-true-western-union-experiments-ripples-xrapid/

- **Apr. 26, 2018** – **Ripple announced five new xVia customers: FairFX, Exchange4Free, RationalFX, UniPAY** and **MoneyMatch**.

  Source: https://www.businesswire.com/news/home/20180426005305/en/Ripple-Grows-Its-Global-Payments-Network-With-Five-New-xVia-Customers

- **Oct. 1, 2018 – Ripple formally announces the commercial launch of xRapid at its Swell 2018 conference. It also announces that three companies were using xRapid in production: MercuryFX, Cuallix, and Catalyst Corporate Federal Credit Union.**

  Source: https://www.cnbc.com/2018/10/01/ripple-xrp-cryptocurrency-product-xrapid-goes-live-for-first-time.html

- **Jan. 8, 2019 – Ripple announces Euro Exim Bank has signed up for xRapid – the first bank to do so.**

  Source: https://ripple.com/insights/ripplenet-surpasses-200-customers-worldwide/; https://www.coindesk.com/euro-exim-bank-taps-ripples-xrapid-for-cross-border-settlements

- **Feb. 4, 2019 – Ripple is named to the Forbes Fintech 50: The Most Innovative Fintech Companies In 2019**

  Source: https://www.forbes.com/fintech/2019/#55fad47a2b4c

- **April 8, 2019 – Ripple's xRapid product receives an honorable mention in the "developing-world technology" category in Fast Company's third annual World Changing Ideas Awards**

  Source: https://www.fastcompany.com/90329244/world-changing-ideas-2019-all-the-winners-finalists-and-honorable-mentions

- **April 16, 2019 – Ripple is named to the Forbes Blockchain 50 list for 2019**

  Source: https://www.forbes.com/sites/michaeldelcastillo/2019/04/16/blockchain-50-billion-dollar-babies/?sh=4647f85a57cc

- **June 17, 2019 – Ripple and MoneyGram announces strategic partnership, including two-year xRapid deal.**

Source: https://ir.moneygram.com/news-releases/news-release-details/moneygram-announces-strategic-partnership-ripple

- **Sept-Oct. 2019 – Ripple rebrands xRapid as "On-Demand Liquidity" (ODL).**

  Sources: https://dailyhodl.com/2019/10/11/confirmed-ripple-says-major-rebranding-underway-xrp-powered-xrapid-transforming-to-on-demand-liquidity

- **Dec. 20, 2019 – Ripple announced $200 million in Series C funding, led by Tetragon with participation from SBI Holdings and Route 66 Ventures.**

  Source: https://ripple.com/insights/ripple-caps-record-year-with-200-million-series-c-funding/

- **June 16, 2020 – Ripple is listed on the CNBC Disruptors 50 list for 2020.**

  Source: https://www.cnbc.com/2020/06/16/ripple-disruptor-50.html